BIOLOGY

FBISE NOTES

10TH CLASS

Faderal Board Islamabad

Presented by:

Urdu Books Whatsapp Group

STUDY GROUP

0333-8033313
راؤایاز

0343-7008883
پاکستان زندہ باد

0306-7163117
محمد سلمان سلیم

MULTIPLE CHOICE QUESTIONS

■ *Choose the correct answer from the following choices.*

i. Which of the following is an example of simple harmonic motion?
- a) **Motion of a simple pendulum**
- b) **The motion of ceiling fan**
- c) **The spinning of the Earth on its axis**
- d) **A bouncing ball on a floor**

ii. If the mass of the bob of a pendulum is increased by a factor of 3, period of the pendulum's motion will
- a) **be increased by a factor of 2**
- b) **remain same**
- c) **be decreased by a factor of 2**
- d) **be decreased by a factor of 4**

iii. Which of the following devices can be used to produce both a transverse and longitudinal wave?
- a) **a string**
- b) **a ripple tank**
- c) **a helical spring (slinky)**
- d) **a tuning fork**

iv. Waves transfer
- b) **energy**
- b) **frequency**
- d) **wavelength**
- d) **velocity**

v. Which of the following is a method of energy transfer?
- a) **Conduction**
- b) **Radiation**
- c) **Wave motion**
- d) **All of these**

vi. In a vacuum all electromagnetic waves have the same
- a) **speed**
- b) **frequency**
- c) **amplitude**
- d) **wavelength**

vii. A large ripple tank with a vibrator working at a frequency of 30 Hz produces 25 complete waves in a distance of 50 cm. The velocity of the wave is
- a) **53 cms^{-1}**
- b) **60 cms^{-1}**
- c) **750 cms^{-1}**
- d) **1500 cms^{-1}**

ix. Which of the following characteristics of a wave is independent of the others
- a) **speed**
- b) **frequency**
- c) **Amplitude**
- d) **wavelength**

x. The relation between v, f and In a vacuum all electromagnetic waves have the same
- b) **speed**
- b) **frequency**
- d) **amplitude**
- d) **wavelength**

ANSWER KEY

i.	(a)	ii.	(b)	iii.	(c)	iv.	(a)	v.	(d)
vi.	(a)	vii.	(b)	viii.	(c)	ix.	(b)		

MULTIPLE CHOICE QUESTIONS

- *Choose the correct answer from the following choices.*

i. Which is an example of a longitudinal wave?

(a) sound wave (b) light wave
(c) radio wave (d) water wave

ii. How does sound travel from its source to your ear?

(a) by change in air pressure (b) by vibrating in wires or strings
(c) by electromagnetic wave (d) by infrared waves

iii. Which form of energy is sound?

(a) electrical (b) mechanical
(c) thermal (d) chemical

iv. Astronauts in space need to communicate with each other by radio links because

(a) sound waves travel very slowly in space
(b) sound waves travel very fast in space
(c) sound waves cannot travel in space
(d) sound waves have low frequency in space

v. The loudness of a sound is most closely related to its

(a) frequency (b) period
(c) wavelength (d) amplitude

vi. For a normal person, audible frequency range for sound wave lie between

(a) 10 Hz and 10 KHz (b) 20 Hz and 20 KHz
(c) 25 Hz and 25 KHz (d) 30 Hz and 30 KHz

vii. When the frequency of a sound wave is increased, which of the following will decrease?

i. Wavelength **ii. Period** **iii. Amplitude**

(a) i only (b) iii only
(c) i and ii only (d) i and iii only

i.	(a)	ii.	(a)	iii.	(b)	iv.	(c)	v.	(d)	vi.	(b)	vii.	(c)

MULTIPLE CHOICE QUESTIONS

- *Choose the correct answer from the following choices.*

i. Which of the following quantities is not changed during refraction of light?
   (a) its direction (b) Its speed
   (c) its frequency (d) its wavelength

ii. A converging mirror with a radius of 20 cm creates a real image 30 cm from the mirror. What is the object distance?
   (a) 5.0 cm (b) 7.5 cm
   (c) 15 cm (d) 20 cm

iii. An object is placed at the centre of curvature of a concave mirror. The image produced by the mirror is located.
   (a) out beyond the centre of curvature
   (b) at the centre of curvature
   (c) between the centre of curvature and the focal point
   (d) at the focal point

iv. An object is 14 cm in front of a convex mirror. The image is 5.8 cm behind the mirror. What is the focal length of the mirror?
   (a) 4.1 cm (b) 8.2 cm
   (c) 9.9 cm (d) 20 cm

v. The index of refraction depends on
   (a) the focal length (b) the speed of light
   (c) the image distance (d) the object distance

vi. Which type of image is formed by a concave lens on a screen?
   (a) inverted and real (b) inverted and virtual
   (c) upright and real (d) upright and virtual

vii. Which type of image is produce by the converging lens of human eye if it views a distant object?
   (a) real, erect and same size (b) real, inverted & diminished
   (c) virtual, erect & diminished (d) virtual, inverted & magnified

viii. Image formed on a camera is
   (a) real, inverted and diminished
   (b) virtual, upright and diminished
   (c) virtual, upright and magnified
   (d) real, inverted and magnified

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- عمران سیریز کے شوقین کیلئے علیحدہ سے عمران سیریز گروپ موجود ہے۔
- **لیڈیز کے لئے الگ گروپ کی سہولت موجود ہے جس کے لئے ویریفکیشن ضروری ہے۔**
- اردو کتب / عمران سیریز یا سٹڈی گروپ میں ایڈ ہونے کے لئے ایڈمن سے وٹس ایپ پر بذریعہ میسیج رابطہ کریں اور جواب کا انتظار فرمائیں۔ برائے مہربانی اخلاقیات کا خیال رکھتے ہوئے موبائل پر کال یا ایم ایس کرنے کی کوشش ہر گز نہ کریں۔ ورنہ گروپس سے تو ریموو کیا ہی جائے گا بلاک بھی کیا جائے گا۔

نوٹ: ہمارے کسی گروپ کی کوئی فیس نہیں ہے۔ سب فی سبیل اللہ ہے

0306-7163117	0343-7008883	0333-8033313
محمد سلمان سلیم	پاکستان زندہ باد	راؤ ایاز

پاکستان زندہ باد | پاکستان پائندہ باد

اللہ تبارک تعالیٰ ہم سب کا حامی و ناصر ہو

ix. If a ray of light in glass in incident on an air surface at an angle greater than the critical angle, the ray will
(a) refract only
(b) reflect only
(c) partially refract and partially reflect
(d) diffract only

x. The critical angle for a beam of light passing from water into air is 48.8 degrees. This means that all light rays with an angle of incidence greater than this angle will be
(a) Absorbed
(b) totally reflected.
(c) partially reflected and partially transmitted
(d) totally transmitted

ANSWERS

i.	(d)	ii.	(c)	iii.	(b)	iv.	(c)	v.	(b)
vi.	(d)	vii.	(b)	viii.	(a)	ix.	(b)	x.	(b)

MULTIPLE CHOICE QUESTIONS

- ***Choose the correct answer from the following choices:***

i. A positive electric charge
   (a) attracts other positive charge (b) repels other positive charge
   (c) attracts a neutral charge (d) repels a neutral charge

ii. An object gains excess negative charge after being rubbed against another object, which is:
   (a) neutral (b) negatively charged
   (c) positively charged (d) either a, b or c

iii. Two uncharged objects A and B are rubbed against each other. When object B is placed near a negatively charged object C, the two objects repel each other. Which of these statements is true about object A?
   (a) remains uncharged (b) becomes positively charged
   (c) becomes negatively charged (d) unpredictable

iv. When you rub a plastic rod against your hair several times and put it near some bits of paper, the pieces of papers are attracted towards it. What does this observation indicate?
   (a) the rod and the paper are oppositely charged
   (b) the rod acquires a positive charge
   (c) the rod and the paper have the same charges
   (d) the rod acquires a negative charge

v. According to Coulomb's law, what happens to the attraction of two oppositely charged objects as their distance of separation increases?

(a) increases (b) decreases
(c) remains unchanged (d) cannot be determined

vi. The Coulomb's law is valid for the charges which are
(a) moving and point charges (b) moving and non-point charges
(c) stationary and point charges (d) stationary and large size charges

vii. A positive and a negative charge are initially 4 cm apart. When they are moved closer together so that they are now only 1cm apart, the force between them is
(a) 4 times smaller than before (b) 4 times larger than before
(c) 8 times larger than before (d) 16 times larger than before

viii. Five joules of work is needed to shift 10C of charge from one place to another. The potential difference be ween the places is
(a) 0.5V (b) 0.2V
(c) 5V (d) 10V

ix. Two charged spheres are separated by 2mm. Which of the following would produce the greatest attractive force?
(a) +1q and +4q (b) −1q and −4q
(c) +2q and +2q (d) +2q and −2q

x. Electric field lines
(a) always cross each other (b) never cross each other
(c) cross each other in the region of strong field
(d) cross each other in the region of weak field

xi. Capacitance is defined as
(a) VC (b) Q/V
(c) QV (d) V/Q

ANSWERS

i.	(b)	ii.	(b)	iii.	(b)	iv.	(a)	v.	(b)
vi.	(c)	vii.	(b)	viii.	(c)	ix.	(d)	x.	(b)
ix.	(b)								

MULTIPLE CHOICE QUESTIONS

- ***Choose the correct answer from the following choices:***

i. An electric current in conductors is due to the flow of
(a) positive ions (b) negative ions
(c) positive charges (d) free electrons

ii. What is the voltage across a 6 Ω resistor when 3 A of current passes through it?
(a) 2 V (b) 9 V
(c) 18 V (d) 36 V

iii. What happens to the intensity or the brightness of the lamps connected in series as more and more lamps are added?
(a) increases (b) decreases
(c) remains the same (d) cannot be predicted

iv. Why should household appliances be connected in parallel with the voltage source?
(a) to increase the resistance of the circuit
(b) to decrease the resistance of the circuit
(c) to provide each appliance the same voltage as the power source
(d) to provide each appliance the same current as the power source

v. Electric potential and e.m.f
(a) are the same terms (b) are the different terms
(c) have different units (d) both (b) and (c)

vi. When we double the voltage in a simple electric circuit, we double the
(a) current (b) power
(c) resistance (d) both (a) and (b)

vii. If we double both the current and the voltage in a circuit while keeping its resistance constant, the power
(a) remains unchanged (b) halves
(c) four times (d) quarter

viii. What is the power rating of a lamp connected to a 12 V source when it carries 2.5 A?
(a) 4.8 W (b) 14.5 W
(c) 30 W (d) 60 W

ix. The combined resistance of two identical resistors, connected in series is 8 Ω. Their combined resistance in a parallel arrangement will be
(a) 2 Ω (b) 4 Ω
(c) 8 Ω (d) 12 Ω

ANSWERS

i.	(d)	ii.	(c)	iii.	(b)	iv.	(c)	v.	(a)
vi.	(a)	vii.	(c)	viii.	(c)	ix.	(a)		

MULTIPLE CHOICE QUESTIONS

- *Choose the correct answer from the following choices.*

i. **Which statement is true about the magnetic poles?**
(a) unlike poles repel (b) like poles attract
(c) magnetic poles do not effect each other
(d) a single magnetic pole does not exist

ii. **What is the direction of the magnetic field lines inside a bar magnet?**
(a) from north pole to south pole (b) from south pole to north pole
(c) from side to side (d) there are no magnetic field lines

iii. **The presence of a magnetic field can be detected**
(a) Small mass (b) Stationary positive charge
(c) Stationary negative charge (d) Magnetic compass

iv. **If the current in a wire which is placed perpendicular to a magnetic field increases, the force on the wire**
(a) Increase (b) Decreases
(c) Remains the same (d) Will be zero

v. **A.D.C motor converts**
(a) Mechanical energy into electrical energy
(b) Mechanical energy into chemical energy
(c) Electrical energy into mechanical energy
(d) Electrical energy into chemical energy

vi. **Which part of a D.C. motor reverses the direction of current through the coil every half-cycle?**
(a) the armature (b) the commutator
(c) the brushes (d) the slip rings

vii. **The direction of induced e.m.f in a circuit is in accordance with conservation of**
(a) mass (b) charge
(c) momentum (d) energy

viii. **The step-up transformer**
(a) increases the input current (b) increases the input voltage
(c) has more turns in the primary (d) has les turns in the secondary coil

ix. **The turn ratio of a transformer is 10. It means**
(a) $I_s = 10\ I_p$ (b) $N_s = N_p / 10$
(c) $N_s = 10\ N_p$ (d) $V_s = V_p / 10$

i.	(d)	ii.	(b)	iii.	(d)	iv.	(a)	v.	(c)
vi.	(b)	vii.	(d)	viii.	(b)	ix.	(h)		

MULTIPLE CHOICE QUESTIONS

- ***Choose the correct answer from the following choices:***

i. The process by which electrons are emitted by a hot metal surface is known as
   (a) boiling (b) evaporation
   (c) conduction (d) thermionic emission

ii. The particles emitted from a hot cathode surface are
   (a) positive ions (b) negative ions
   (c) protons (d) electrons

iii. The logical operation performed by this gate is diagram
   (a) AND (b) NOR
   (c) NAND (d) OR

iv. AND gate can be formed by using two
   (a) NOT gates (b) OR gates
   (c) NOR gates (d) NAND gates

v. The output of a two-input NOR gate is 1 when:
   (a) A is 1 and B is 0 (b) A is 0 and B is 1
   (c) both A and B are 0 (d) both A and B are 1

vi. If X = A.B, then X is 1 when:
   (a) A and B are 1 (b) A or B is 0
   (c) A is 0 an B is 1 (d) A is 1 and B is 0

vii. The output of a NAND gate is 0 when
   (a) both of its inputs are 0 (b) both of its inputs are 1
   (c) any of its inputs is 0 (d) any of its inputs is 1

ANSWERS

i.	(d)	ii.	(d)	iii.	(c)	iv.	(d)	v.	(c)
vi.	(a)	vii.	(b)						

...information and world communication.

MULTIPLE CHOICE QUESTIONS

- ***Choose the correct answer from the following choices:***

i. In computer terminology information means
   (a) any data (b) raw data
   (c) processed data (d) large data

ii. Which is the most suitable means of reliable continuous communication between an orbiting satellite and Earth?
   (a) microwaves (b) radio waves
   (c) sound waves (d) any light wave

iii. The basic operations performed by a computer are
   (a) arithmetic operations (b) non-arithmetic operations
   (c) logical operations (d) both a and c

iv. The brain of any computer system is
   (a) monitor (b) memory
   (c) CPU (d) control unit

v. Which of the following is not processing?
   (a) arranging (b) manipulating
   (c) calculating (d) gathering

vi. From which of the following you can get information almost about everything.
   (a) book (b) teacher
   (c) computer (d) internet

vii. What does the term e-mail stand for?
   (a) emergency (b) electronic mail
   (c) extra mail (d) external mail

ANSWERS

i.	(c)	ii.	(a)	iii.	(d)	iv.	(c)	v.	(a)
vi.	(d)	vii.	(b)						

MULTIPLE CHOICE QUESTIONS

- *Choose the correct answer from the following choices:*

i. Isotopes are atoms of same element with different
   (a) atomic mass (b) atomic number
   (c) number of protons (d) number of electrons

ii. One of the isotopes of uranium is $^{238}_{92}U$. The number of neutrons in this isotope is
   (a) 92 (b) 146
   (c) 238 (d) 330

iii. Which among the following radiations has more penetrating power?
   (a) a beta particle (b) a gamma ray
   (c) an alpha particle (d) all have the same penetrating ability

iv. What happens to the atomic number of an element which emits one alpha particle and a beta particle?
   (a) increases by 1 (b) stays the same
   (c) decreases by 2 (d) decreases by 1

v. The half life of a certain is isotope is 1 day. What is the quantity of the isotope after 2 days.
   (a) one half (b) one quarter
   (c) one eighth (d) none of these

vi. When uranium (92 protons) ejects a beta particle, how many protons are left in the remaining nucleus?
   (a) 92 protons (b) 91 protons
   (c) 90 protons (d) 89 protons

vii. Release of energy by the sun is due to
   (a) nuclear fission (b) nuclear fusion
   (c) burning of gases (d) chemical reaction

viii. When a heavy nucleus splits into two lighter nuclei, the process would
   (a) release nuclear energy (b) absorb nuclear energy
   (c) release chemical energy (d) absorb chemical energy

ix. The reason carbon-dating works is that
   (a) Plants and animals are such strong emitters of carbon-14
   (b) After a plant or animal dies, it stops taking in fresh carbon-14
   (c) There is so much non-radioactive carbon dioxide in the air
   (d) When a plant or an animal dies.

ANSWERS

i.	(a)	ii.	(b)	iii.	(c)	iv.	(d)	v.	(b)
vi.	(b)	vii.	(b)	viii.	(a)	ix.	(a)		

SHORT QUESTIONS

[Very Important] What is simple harmonic motion? What are the necessary conditions for a body to execute simple harmonic motion?

The special kind of vibratory motion of a body, whose acceleration is directly proportional to its displacement from mean or equilibrium position, is called **simple harmonic motion.**

Conditions:

i) Acceleration is directly proportional to its displacement.
ii) Acceleration is directed towards the mean position.

Think of several examples in everyday life of motion that are simple harmonic.

i) Oscillating simple pendulum
ii) Oscillating mass spring system
iii) Pendulum of wall clock

[Very Important] What are damped oscillations? How damping progressively reduces the amplitude oscillations?

The continuous decrease of amplitude of oscillator is called damped oscillator and the oscillations are called **damped oscillations.**

Simple harmonic oscillations are ideal. In case of real oscillator, there is continuous decrease of amplitude which ultimately becomes zero. It is due to resistance of medium which reduces the mechanical energy of system. This resistive force is called **damping force**.

[Important] How can you define the term wave? Elaborate the difference between mechanical and electromagnetic waves? Give examples of each.

Wave:

Wave is the mean to transport energy from one place to another without transport of matter.

Mechanical Waves:

The waves which require medium for their propagation. For example sound waves, water waves and rope waves.

Electromagnetic Waves:

The waves which don't require any medium for their propagation. For example light waves are electromagnetic waves.

Distinguish between longitudinal and transverse waves with suitable examples.

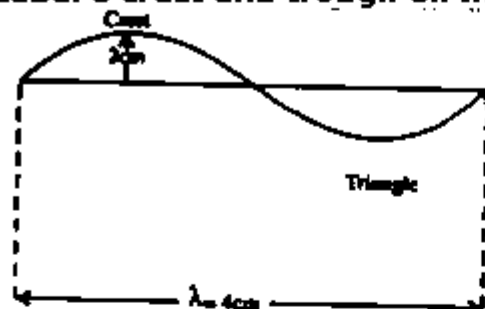
The waves due to which the direction of oscillations are along the direction of propagation of waves are called "Longitudinal" waves. And the direction of oscillations are perpendicular to the direction propagation of waves are called transverse waves.

Examples of longitudinal waves:

i) Sound Waves ii) Waves on slinky spring.

Examples of Transverse Waves:

i) Water waves ii) String waves

Draw a transverse wave with amplitude of 2 cm and a wavelength of 4 cm. Label a crest and trough on the wave.

[Very Important] Derive a relationship between speed, frequency and wavelength of wave. Write a formula relating speed of a wave to its time period and wavelength.

If the speed of waves is **(v)** and the time period of the plate producing waves is **T** seconds, then the distance covered by the wave will be **vT**. As it is equal to the wavelength, therefore,

$\lambda = vT$

$v = \lambda/T$ or $\lambda \times 1/T$

We know that $1/T = f$ then

$V = f\lambda$

Waves are the means of energy transfer without transfer of matter. Justify this statement with the help of a simple experiment.

If we hold an end of a long string and give it vibrations. Then a wave is set up on the string and the other end also starts vibrating automatically (after some time). It confirms the transfer of energy by the help of wave on string. It confirms the transfer of energy and not the transfer of mass.

[Important] Explain the following properties of waves with reference to ripple tank experiment.

1-Reflection:

When a waves **strike** an obstacle placed in its path, it will be **reflected back** in a particular direction. This phenomenon is called **reflection** of waves.

Laws of reflection are:

i) Angle of incident ray (**Angle i**) and reflected ray (**Angle r**) will be **equal**.

ii) (**Angle i**), (**Angle r**) and the **normal**, all **lies at the same plane**.

2-Refraction:

When waves **enter** from **one medium to another**, a part of it is reflected in the same medium while the **other part is transmitted into the other medium**. This phenomenon is called refraction of waves.

The **wave speed** and **wavelength** of a wave **change** in the second medium but **frequency does not change.**

(*** draw figure from book)

3-Differection:

The **bending** of waves around obstacles is called diffraction.

For example, radio and TV waves reach in those areas where they could not reach directly due to diffraction

Does increasing the frequency of a wave also increase its wavelength? If not, how are these quantities related?

We know the relation V =f λ.

It clearly shows if frequency increases then wavelength decreases because the product is constant that is velocity. Velocity is constant until medium is constant.

[Important] A ball is dropped from a certain height onto the floor and keeps bouncing. Is the motion of the ball simple harmonic? Explain.

As the ball is dropped from certain height "h" onto the floor having initial P.E = mgh and keeps bouncing. It is observed after each bounce its height and its P.E are decreasing. And time period is also decreasing. As time period is not constant and total energy is not conserved so the motion of the ball is not simple harmonic motion.

A student performed two experiments with a simple pendulum. He use two bobs of different masses by keeping other parameters constant. To his astonishment the time period of the pendulum did not change! Why?

Formula of time period of simple pendulum is independent of mass of bob. By change of mass of bob no change in time period is expected.

What types of waves do not require any material medium for their propagation?

Electromagnetic waves do not require any material medium for their propagation. For example X-ray, Radio waves, TV waves etc.

Plane waves in the ripple tank undergo refraction when they move from deep to shallow water. What change occurs in the speed of the waves?

When water waves coming from deeper portion of ripple tank enter into another region of shallow water region, then these show refraction. Their speed in both the regions is not same due to change of value of wavelengths.

[Important] Define vibrational motion.

The to and fro motion of a body about is its mean position is called vibrational motion. For example simple pendulum, flapping of wings of birds etc. The motion of vibrating body from one extreme position to other and then back to the same is called one **vibration**.

How spider detects its prey.

A spider detects its prey due to vibration produced in the web.

Define Time Period and Frequency?

- The time to complete one vibration is called **time period**.
- The number of vibrations in one second is called **frequency**.

[Very Important] What do you know about damping of shock absorber of automobiles.

Shock absorbers in automobiles are one of the practical applications of damping motion. A shock absorber consists of a piston moving through a liquid such as oil. When the car travels over a bump on road, the car may vibrate violently. The shock absorbers damp these vibrations and convert their energy into heat energy of the oil. Thus the passengers do not feel vibrations.

[Very Important] How pendulum clock was invented?
Christian Huygens invented the pendulum clock in 1656. He was inspired by the work of Galileo who had discovered that all pendulums of the same length took the same amount of time to complete one full swing.

What do you know about the speeds of Longitudinal and Transverse waves through various matters?

- Longitudinal waves move faster through solids than through gases or liquids.
- Transverse waves move through solids at a speed of less than half of the speed of longitudinal waves. It is because the restoring force exerted during this up and down motion of particles of the medium is less than the restoring force exerted by a back and forth motion of particles of the medium in case of longitudinal waves.

Which type of wave carry more energy. High frequency waves or low frequency?
To generate a high frequency wave required more energy per second, therefore high frequency waves carry more energy than low frequency waves.

LONG QUESTIONS

[Very Important] Explain the motion of mass attached with a spring on a horizontal and frictionless plane is simple harmonic motion.

- Consider the following figure.
  (Draw figure from book)
- In the figure, a spring is placed on a smooth surface. Its **one end** is attached to firm support. A **mass 'm'** is attached on its other end.
- In this state, there is **no extension** in spring, i.e it is in **equilibrium state.**
- If a force **'F_{ext}' is exerted** on mass toward right, the **length** of spring will be **increased** by an amount **'x'**. Mass will move from its position **'O' to 'A'.**
- As per **Hooke's law**

$$F_{ext} \propto x$$
$$F_{ext} = kx$$

- Here k is a constant, and is called spring constant. **Value of k** is obtained by the equation ($k = F_{ext}/x$)
- The **ratio** of External Force (**F_{ext}**) and increase in length (**x**) is called **spring constant.** Its unit is **Nm^{-1}.**
- After **removing** the **External Force** (F_{ext}), spring moves towards its **original position** 'O', but now $F = -kx$
- Acceleration 'a' of the mass 'm' can be found as ($a = F/m = -kx/m$). **Acceleration is always directed towards its original position.**
- Due to **inertia**, mass **'m' does not stop** at 'O', but it reaches upto **A'**.
- After **reaching to A'**, spring **again** tries to reach to its **original position 'O'**, but **again pass it.**
- In this way mass start moving **to and fro about its original position 'O'.**

- Therefore, motion of mass attached to spring is called **simple harmonic motion.**
- **Time Period** (T) of mass attached to spring can be found by the following equation.

$$T = 2\pi\sqrt{m/k}$$

Definition of SHM:

"The acceleration of a body executing S.H.M is directly proportional to the displacement of the body from equilibrium position, and is always directed towards the equilibrium position."

Kinetic and potential energies of mass attached to spring at different displacement.

- Consider a horizontal spring-mass system. The mass is oscillating simple harmonic motion under restoring force.
- At the mean position, it has maximum velocity so it has maximum kinetic energy and zero potential energy.
- At the extreme position it has maximum potential energy and zero velocity so kinetic energy is zero.
- At any displacement it has partially kinetic and partially potential energy, but total energy is constant.

[Important] Explain the motion of a ball in a bowl. Show that it is simple harmonic motion.

- Consider a ball is placed at equilibrium position "O" the bottom of a bowl.
- When the ball is at the bottom of the bowl, its weight mg is equal to the reaction R so net force is zero.
- When a ball is gently displaced form the centre of a bowl it starts oscillating about the centre due to force of gravity which acts as a restoring force.
- Once the ball is places at position A and then released, it will accelerate towards the mean position under its weight.
- At the mean position it gains maximum velocity and momentum, so it moves up to the point B due to inertia.
- At B it has zero velocity so zero kinetic energy but has maximum potential energy.
- Again from point B it will move toward O under the restoring force having maximum velocity at O, but does not stop at O and will go up to A.
- In this way the ball will continue to oscillate between the points A and B about point O, it has simple harmonic motion.

[Important] What is a simple pendulum; explain the motion of the bob is simple harmonic motion.

*See figure from book

- Simple pendulum consists of a **single isolated bob**, which is **suspended** from a **frictionless support** by means of **light inextensible string**.

- In **equilibrium** position, it is held stationary in vertical position and its **bob is at 'O'.**
- If the bob is disturbed from **O to A**, it **start moving about its mean position**. This to and fro motion is between points A and B.
- Its **acceleration** remains towards 'O'.
- Hence, we can say that motion of simple pendulum is also simple harmonic motion.
- **Time period** (T) of simple pendulum can be found by the following equation.

$$T = 2\pi\sqrt{l/g}$$

- Where 'l' is the length of pendulum and 'g' is gravitational acceleration.

[Very Important] Write down the characteristics of SHM and give some examples from daily life?

Characteristics:

i) SHM is a vibratory motion.
ii) A body doing S.H.M, **always vibrate about its mean** (equilibrium) position.
iii) Its **acceleration** is always **directed toward its mean** position.
iv) Its **acceleration** is **directly proportional** to its **displacement** from the mean position.
v) Its **velocity is maximum at mean** position, and **minimum at extreme** positions.
vi) The P.E is maximum at extreme position and zero at mean position.
vii) Amplitude of oscillation for SHM remains constant.

Daily Life Examples:

- An oscillating simple pendulum.
- An oscillating mass spring system.
- The motion of a ball and bowl system.
- The motion of the prong of a tuning fork.

[Very Important] Explain the term wave. What are types of waves?

The periodic disturbance spreading all around inside a medium is said to form a wave. It has two types:

1-Mechanical Waves:

Waves that need a medium for their production and propagation are called mechanical waves. For example waves produced in water and string. Mehcanical waves have further two types:

- **Longitudinal Waves:** Those waves in which the particles of the medium vibrate parallel to the direction of propagation of the wave are called compressional or longitudinal waves. For example sound waves.
- **Transverse Waves:** Those waves in which the particles of the medium vibrate perpendicular to the direction of propagation of the wave are called transverse waves. For example waves produced by dipping a pencil in water. Those parts of transverse waves where the particles of the medium are above the normal

position are called **crest** and parts where the particles of the medium are below their normal position are called **trough**.

2-Electromagnetic Waves:

The waves which do not require any medium for their propagation are called electromagnetic waves. For example X-ray, light waves, radio and TV waves.

Explain waves as carrier of energy and write the two methods of transfer of energy.

There are **two** methods of transferring energy.

i) Through matter.
ii) Through waves.

Through matter:

i) When gun is fired, bullet get energy and moves towards target. When it hits the target, it transfers the energy to it. As a result breaking/damage takes place.
ii) Running water in dams is also an example. Water transfers its K.E to turbine blades, due to which turbine start rotating and electricity is produced.

Through Waves:

i) Fill a tub with water.
ii) Move a rod up and down in it. Waves are produced in water and moves away from rod.
iii) Place of cork on other end of tub on water surface.
iv) You will see cork will also move up and down.
v) In this process, energy supplied by rod and this energy transfers upto the cork by water waves.

[Very Important] Give the characteristics of wave motion.

Crests and Troughs:

The points at which the displacement is maximum are called crests and where the value of displacement of oscillations is minimum are troughs in a transverse waves.

Amplitude:

The maximum value to displacement on either sides of mean position of an oscillatory proportion is called as amplitude.

Phase:

The physical quantity which specify the value of displacement along with its direction w.r.t the mean position is called phase.

Wave length:

The distance between two successive points on a wave having same phases is called wave length.

Cycle:

One complete vibration is called one cycle.

Frequency

The number of vibrations completed in one second is called frequency.

Period:

The time required to complete one vibration is called time period.

Wave front:

The imaginary surface touching all those points which are in same phase is called wave front.

Spherical Wave front:

The wave front due to waves generated by a point source, which spread all around the point source, from wave fronts in shape of concentric spheres.

Plane Wave front:

The wave front due to a number of waves moving parallel to one another is in shape of plane wave front.

[Very Important] What is ripple tank? Explain the construction and working of a ripple tank.

Simple apparatus, called ripple tank is **used to observe the properties of waves** (e.g. reflection, refraction, interference, diffraction etc).

Ripple Tank: -

- This apparatus consists of a **rectangular tray** with **glass bottom**.
- It is placed nearly **half meter above** the surface of a table.
- **Waves** are **produced** on the surface of water with the help of a **vibrator**.
- This **vibrator** is an **oscillating electric motor** which is fixed on a **wooden plate**.
- This **plate** is suspended by means of **rubber bands** and its **lower end touches** the water surface.
- On setting **vibrator on**, this plate starts vibrating and **straight waves** are generated on the water surface.

(****Draw Figure here from book.*)

- A **bulb** is hung over the tray. With the help of its light, the **images of water waves** is obtained on the white paper or screen.
- The **crests** of the waves appear as **bright lines** on the paper because they function like **convex lens** and **converge** the rays of light falling on them.
- The **troughs** of the waves appear as **dark lines** on the paper because they function like **concave lens** and **diverge** the rays.
- To **generate circular waves**, the vibrating bar is raised up and a **knob** attached to it is lowered in such a way that it touches the water surface.
- For the detailed **analysis** of these moving **waves they should be frozen** by one way or the other. This is done by means of a device called **stroboscope**.
- Stroboscope consists of a **round disc** with **slits** on its **edge**.
- This **disk** can be **rotated** about its centre by putting it into motion by a finger.
- When we see through this disc, **we see waves only**, when a slit passes against our eye.
- If we **adjust the speed** of stroboscope, so that a slit in front of our eye is replaced by another during the time in which the waves move forward by **one wavelength**, the waves appear to be stationary and we say that their motion is "**frozen**".

NUMERICAL PROBLEMS

Q.10.1 The time period of a simple pendulum is 2 S. What will [illegible] Earth? What will be its length on the moon if g [illegible] 10ms^{-2}.

Solution Give data:

Time period T = 2 *sec.*

$g_e = 10\ ms^{-2}$

$g_m = g_e/6 = 10/6 = 1.67\ ms^{-2}$

Find length of the pendulum on Earth and Moon. L_e & L_m =

Time period of a simple pendulum is $T = 2\pi\sqrt{\frac{L}{g}}$ .....(1)

Squaring and arranging the equation for length "l"

$$T^2 = 4\pi^2\frac{L}{g} \quad = \quad L_e = \frac{g_e T^2}{4\pi^2} \text{ ......(2)}$$

Putting values we get: $L_e = \frac{10\times(2)^2}{4(3.14)^2} = L_e = 1.02$ m

For moon we get $L_m = \frac{g_m T^2}{4\pi^2}$ ......(3)

Putting values we get $L_e = \frac{1.67\times(2)^2}{4(3.14)^2} = L_m = 0.17$ m

Q.10.2 A pendulum of length 0.99 m is taken to the moon by [illegible] period of the pendulum is 4.9s. What is the value of g [illegible] moon?

Solution: *Give Data:*

Length $l = 0.99m$

Period $T = 4.9$ *sec.*

Time period of a simple pendulum is $T = 2\pi\sqrt{\frac{L}{g}}$ .....(1)

Squaring and arranging the equation for "g"

$$T^2 = 4\pi^2\frac{L}{g} \quad = \quad g = 4\pi^2\frac{L}{T^2}$$

Putting values we get: $g = 4\times(3.14)^2\times(\frac{0.99}{4.9^2})$

$g = 4\times(9.88)\times(\frac{0.99}{4.9^2})$

$g = (39.5)\times(\frac{0.99}{24.01})$

$g = 39.5\times 0.042$

$g = 1.65 ms^{-2}$

Q.10.3. Find the time periods of a simple pendulum of 1 meter length, placed earth and on moon. The value of g on the surface of moon is 1/6th of value on Earth. Where g_e is $10ms^{-2}$.

Solution: *Give Data:*

Length $L = 1m$

$g_e = 10\ ms^{-2}$

$g_m = g_e/6 = 10/6 = 1.67\ ms^{-2}$

Time period of a simple pendulum is $T = 2\pi\sqrt{\frac{L}{g}}$ ....(1)

We write time period on Earth (e): $T_e = 2\pi\sqrt{\frac{L}{g_e}}$

Putting values we get: $T_e = 2\pi\sqrt{\frac{1}{10}}$

This implies $T_e = 2\times(3.14)\times(0.316)$

$T_e = 1.985$ sec. This implies $T_e = 2$ sec. (Time period on Earth

We write time period on Moon (m): $T_m = 2\pi\sqrt{\frac{L}{g_m}}$

$T_m = 2\pi\sqrt{\frac{1}{1.67}}$

$T_m = 2\times(3.14)\times(0.774)$

$T_m = 4.9$ sec. Time period on Moo

10.4. A simple pendulum completes one vibration in two seconds. Calculate length when g is $10.0\ ms^{-2}$.

Solution: *Give Data:*

Time period $T = 2$ *Sec.*

$g_e = 10\ ms^{-2}$

Time period of a simple pendulum is $T = 2\pi\sqrt{\frac{L}{g}}$ .....(1)

Squaring and arranging the equation for "*L*"

$L_e = \frac{g_e T^2}{4\pi^2}$

Putting values we get: $L_e = \frac{10\times(2)^2}{4(3.14)^2}$

$L_e = 1.02\ m$

Q.10.5. If 100 waves pass through a point of medium in 20 seconds. What is the frequency and the time period of the wave? If its wavelength is 6 cm, calculate the wave speed.

Solution: *Give Data.*

No. of waves passed = 100

Time taken = 20 sec

Frequency = ?

Wavelength λ = 6 cm = 0.6 m we know 1 m = 100 cm

Wave speed v =?

Formula

$$\text{Frequency} = \frac{\text{No. of waves passed}}{\text{time taken}}$$

$$f = \frac{100}{20} = 5\text{Hz}$$ Formula: $fT = 1$, $T = 1/f$

$T = 1/5 = 0.2$ sec.

Formula $f\lambda = v$ = v = (5) × (0.06)

v = 0.3 m/s

Q.10.6. A wooden bar vibrating into the water surface in a ripple tank has a frequency 12 Hz. The resulting wave has a wavelength of 3 cm. what is the speed of the wave?

Solution: *Give Data:*

Frequency f = 12 Hz

Wavelength λ = 3cm = 0.03m we know 1 m = 100 cm

Speed v = ?

Formula

$v = f\lambda$

$v = (12) \times (0.03)$

$v = 0.36\ ms^{-1}$

Q.10.7. A transverse wave produced on a spring has a frequency of 190 Hz and travels along the length of the spring of 90m, in 0.5 s.

a. What is the period of the wave?

b. What is the speed of the wave?

c. What is the wavelength of the wave?

Solution: *Give Data:*

Frequency f = 190 Hz

Wavelength λ = 3cm = 0.03m we know 1 m = 100 cm

Length of the spring d = 90 m

(a) T = ? (b) Speed v = ? (c) Wavelength λ =?

Formula: $fT = 1 = T = 1/f$

$$T = \frac{1}{190} = 0.01 \text{ sec.}$$

Formula: $d = vt$ = $v = \frac{d}{t}$

Putting values we get: $v = \frac{90}{0.5}$ = v = 180 ms^{-1}

Formula $v = f\lambda$. $\lambda = \frac{v}{f}$

Putting values we get: $\lambda = \frac{180}{190}$ = $\lambda = 0.95$ m

Q.10.6. Water waves in a [illegible] cm long. At one point, the water moves up [illegible] 4.8 [illegible] oscillations per second.

a. What is the [illegible] water waves?

b. What is the [illegible]

Given data:

Length of waves (wavelength) λ = 6.0 cm = 0.06 m (we know 1 m = 100 cm)

No. of oscillation (Frequency) f = 4.8 Hz

(a) Speed v = ? (b) Period T = ?

Formula: $fT = 1 = T = 1/f$

$$T = \frac{1}{4.8} = 0.21 \text{ sec.}$$

Formula $v = f\lambda$

Putting values we get: $v = (4.8) \times (0.06)$

$v = 0.29\ ms^{-1}$

Q.10.9. At one end of a ripple tank 80 cm across, a 5 Hz vibrator produces waves whose wavelength is 40mm. Find the time the waves need to cross the tank.

Solution: *Give Data:*

Length of ripple tank $d = 80$ cm $= 0.8$ m (we know 1 m = 100 cm)

Frequency $f = 5$ Hz

Wavelength $\lambda = 40$ mm $= 0.04$ m (we know 1 m = 1000mm)

Time to cross the wave $t = ?$

First we find the speed of wave $v = ?$

Formula $v = f\lambda$

Putting values we get: $v = (5)\times(0.04)$

$v = 0.2\ ms^{-1}$

Formula: $d = v\,t$

Putting values we get: $t = \frac{0.8}{0.2}$ $t = 4$ sec.

Q.10.10. What is the wavelength of the radio waves transmitted by an FM station at 90 MHz? Where 1 M = 10^6 and speed of radio waves is $3\times10^8 ms^{-1}$.

Solution: *Give Data:*

Frequency $f = 90$ MHz (Given 1 M = 10^6)

Speed of radio waves is $c = 3\times10^8 ms^{-1}$

(Note: For radio wave we write "c" instead of "v")

Formula $c = f\lambda$ = $\lambda = \frac{c}{f}$

Putting values we get $\lambda = \frac{3\times10^8}{90\times10^6}$

$\lambda = \frac{3\times10^8}{90\times10^6}$ = $\lambda = 3.33$ m

SHORT QUESTIONS

What is the necessary condition for the production of sound? In which medium sound travels fast? Air, solid or liquid Justify your answer.
Sound wave can be produced by vibrating a body. It travels in a medium whose particles can vibrate. The frequency of vibrations must be greater than 20Hz and less than 20,000Hz. In solids the sound waves have faster speed than in air or liquid (due to larger elasticity).

What is the effect of the medium, on the speed of sound? In which medium sound travels more faster: air, solid or liquid? Justify your answer.
Sound waves are mechanical waves so medium has effect on the speed of sound waves. In solids the sound waves have faster speed than in air or liquid (due to larger elasticity).

How can you prove the mechanical nature of sound by a simple experiment?
- The sound waves are "mechanical waves". It require material medium.
- It can be proved by placing an electric bell inside a glass jar where vacuum is produced.
- The electric bell is made ON, but its sound cannot be heard, due to vacuum and no material medium.
- While before producing vacuum sound will be heard.

What do you understand, by the longitudinal wave? Describe the longitudinal nature of sound wave.
- The waves are said to be longitudinal if the particles of the medium vibrate in the same direction as the direction of propagation of waves.
- Sound waves are mechanical and longitudinal in nature.
- It means the particles of the medium (air, liquid or solid) vibrate in the same direction as the direction of the sound waves travel.

Sound is a form of wave. List at least three reasons to support the idea that sound is a wave.
Sound is a form of wave.
- It gives the sensation of hearing. If we listening sound the membrane of our ear starts vibrating.
- Ultra -sounds (high energy waves) are used in medical sciences.

We know that waves manifest phenomenon of reflection, diffraction and refraction. Does sound also manifest these characteristics
- Yes, sound waves also exhibit the characteristics like reflection, diffraction and refraction.
- Echo is the practical example for the reflection of sound waves.
- Listening of the person in other room is an example of diffraction of sound waves.
- There are example to show the refraction of sound waves by which their speed and direction is change.

==

What is the difference between the loudness and intensity, of sound? Drive the relation between them OR Define Weber-Fechner law.

Loudness:

It is a characteristic of sound by which loud and faint sounds can be distinguished.

Intensity:

Sound energy flowing per second through a unit area held perpendicular to the direction of sound waves is called the intensity of sound.

Relation:

$$L \propto \log I$$
$$L = (\text{Constant}) \log I$$
$$L = k \log I$$

This equation is mathematical representation of **Weber-Fechner law**. Here K is constant of proportionality.

On what factors does the loudness of sound depend?

a. **Amplitude of Vibrating Body: -**
- If **amplitude** of vibrating body is **large** then **loud** sound will be produced and if **amplitude is small then** faint sound will be produced
- e.g. when we strike the drum forcefully loud sound will be produced due to large amplitude.

b. **Area of Vibrating Body: -**
- If the area of vibrating body is larger than loud sound will produced and if the area of vibrating body is small then faint sound will produced
- e.g. sound produced by larger drum will be loud then a small drum.

c. **Distance from vibrating body: -**
- Loudness of sound also depends upon the distance between producer and listener.
- Greater distance between them result in faint sound.
- Less distance between them results in loud sound.

What do you mean by the term intensity level of the sound? Name and define the unit of intensity level of sound.

Difference between loudness of sound and loudness of faintest sound is called intensity level for any sound. The unit of intensity level is bel. The smaller unit of intensity level is decibel and 1 bel = 10 dB.

Intensity Level = $10 \log I/I_o$ dB

What are the units of loudness? Why do we use logarithmic scale to describe the range of the sound intensities we hear?

The unit of loudness is bel. The smaller unit is decibel.

What is difference between frequency and pitch? Describe their relationship graphically.

The number of wave lengths passing through a point in one second is called frequency. Its units are hertz (HZ) and, the pitch is quality of sound due to which a shrill and grave voice can be distinguished. The greater is frequency of sound, the larger is pitch of sound and vice -versa.

===

Describe the effect of change in amplitude on loudness and the effect of change in frequency on pitch of sound. Does sound also manifest these characteristics?

The effect of change of amplitude of sound waves the energy changes and due to which loudness may also change.

The magnitude of sensation of sound is called "loudness". When frequency of sound wave affect the pitch of sound waves. The greater is frequency, the larger is it pitch and vise -versa.

If we clap or speak in front of a building while standing at a particular distance, we rehear our sound after sometime. Can we explain how does this happen?

It is due to the reflection of sound waves. After incident on the walls of they come back into the same medium. That is why we rehear the sound after some time. It is called echo.

What is the audible frequency range for human ear? Does this range vary with the age of people? explain.

As name indicates, it is a range of **sound's frequency**, which a person can hear. A human ear can hear a sound only if its frequency lies between **20 and 20,000 hertz** (Hz). If the frequency of sound is **less or greater** than this range then that sound is **in-audible** and could not be heard. This range can be slightly differs in different persons.

Explain that noise is a nuisance.

The sound which produce jarring and unpleasant effect on our ears are called noise. Noise pollution is a serious issue. Noise has negative effects on human health as it can cause conditions such as hearing loss, sleep disturbance, aggression, hypertension, high stress levels.

Describe the importance of acoustic protection.

In the construction of classrooms, halls and musical halls if the walls are too absorbent then sound level will low and hall will sound dull ard lifeless. There should be balance between reverberation and absorption. It is often advantageous to place reflective surfaces behind the stage to direct sound to the audience. The ceiling of lecture and conference halls are curved so that sound after reflection may reach all the corners of the hall.

What are the uses of ultrasound in medicine?

- Ultrasonic waves are used to diagnose and treat different diseases. The waves are made to enter the patient body through transmitters. These waves are reflected differently by different organs, tissues etc. The reflected waves are amplified to form image which help in detecting the defect in the organs.
- Powerful ultrasound is being used to remove blood clots formed in the arteries.
- Ultrasound is used to get the picture of thyroid gland for diagnosis purposes.

What are uses of ultrasound in technical fields?

- Cracks appear in the interior of moving parts of high speed and heavy machines such as turbines, engine of ships and airplanes. These cracks are not visible but can be detected by ultrasound.
- Germs and bacteria in liquids can also be destroyed by using high intensity ultrasonic waves.

Why two tin cans with a string stretched between them could be better way to communicate than merely shouting through the air.

It is better way to communicate because the sound waves have high speed in solids than air and also maximum intensity (energy) will be transferred through string. While in case of air speed is slow and intensity will be spread over large area.

We can recognize persons speaking with the same loudness from their voice. How is this possible?

We can recognize the persons sound having the same loudness because of the quality of the sound, are pitch.

You can listen your friend round a corner, yet you cannot watch him/her. Why?

The sound waves have larger wave length than light. These are diffracted by corner of well and light waves cannot do so, due to their very small wave length (as compared with size of wall corner). So, without seeing the friend his/ her voice can be heard.

Why must the volume of it stereo in a room with wall -to -wail carpet be turned higher than in a room with a wooden floor?

The wooden floor is more rigid than carpet. The sound waves produce reverberations after reflecting from rigid wooden floor. Therefore, volume of the stereo must be kept smaller. Whereas, in case of carpet this is not the case and waves are mostly absorbed.

A student says that the two terms speed and frequency of the wave refer to the same thing. What is your response?

We know the relation between speed, frequency and wavelength $V = f\lambda$. It shows that speed depends upon frequency and vice versa. But it is not necessarily because in case of refraction of sound waves speed changes by changing only the wavelength.

Two people are listening to the same music at the same distance. They disagree on its loudness. Explain how this could happen.

The two persons listening some same sound, sitting at same distance away from the source, can say that loudness is not same, because the different human ears have different sensitivities.

Is there any difference between echo and reflection of sound? Explain

Reflection:

The process, when sound waves incident on the surface of a medium it bounces back into the first medium, is called reflection of sound waves.

Echo:

Echo is the same of reflection of sound waves but due to sensation of sound persists in our brain for 0.1 sec. To hear echo the time interval between our sound and reflected sound must be at least 0.1 sec. As we know the speed of sound is 334 ms-I at STP. Then to hear echo the minimum distance between obstacle and from the source of sound must be 17m.

Will two separate 50 dB sound together constitute 100dB sound? Explain
Decibel is unit of intensity level. Whose value depends upon the natural loge of intensities of a sound to the intensity of ordinary conversation. Therefore 50dB sound, coming from two sources can not constitute 100 dB sound.

Why ultrasound is useful in medical field?
Ultrasound are harmless energetic sound waves, that is why these are useful in medical field.

How does Stethoscopes operate?
It works on the transmission of sound for the chest piece, via air filled hollow tubes, to the listener's ears. The chest piece usually consists of a plastic disc called diaphragm. If the diaphragm is placed on the patient's body sounds vibrate the diaphragm, creating acoustic pressure waves which after multiple reflection travel up the tubing to the doctor's ears.

What is sound? How it is produced and travel?
Sound is form of energy. It is produced by vibration of bodies. It travels in the form of pressure waves from one place to another.

Why silent whistle is used to call dogs?
Some people use silent whistle to call dogs whose frequency lies between 20,000Hz to 25,000Hz. It is silent for human bug not for dogs. Because the audible frequency range for dogs is much higher.

On which things frequency of tuning fork depends?
Frequency of tuning fork depends on the mass of its prongs. The greater the mass, the lower the frequency of vibration which means the lower the pitch.

How whales can communicate over hundreds & thousands miles?
This is possible in part because sound waves travel five times faster in water than in air. In addition, the temperature characteristics of ocean water – decrease in temperature with depth – create a unique sound phenomenon.

What is the function of large ears of elephants?
Elephants use low frequency sound waves to communicate with one another. Their large ears enable them to detect these low frequency sound waves, which have relatively long wavelengths. Elephants can effectively communicate in this way, even when they are separated by many kilometers.

What are the audible frequency ranges of bats, mice, dogs & cats and humans?
Bats can hear frequencies up to 120,000 Hz. Other animals cannot hear such high pitched sounds. Mice can hear frequencies up to 100,000Hz, dogs upto 35,000Hz and cats upto 25,000Hz and human upto 20,000Hz.

How can you see sound waves?
By using oscilloscope, we can see sound waves.

What are infrasonics?
The sound waves of frequency less than 20Hz are called infrasonics.

What is Sonar. Explain.

- SONAR stands for Sound navigation and ranging.
- It is technique to find depth of ocean and to locate the objects lying deep in the ocean. The ultrasound waves are sent from a transmitter and receiver collects the reflected waves. The time lapse is calculated, knowing the speed of sound in water the distance can be determined.
- SONAR ranging is also used to see the shape and size of objects, in side water.

LONG QUESTIONS

Show with the help of experiment that sound waves are mechanical waves.
Sound waves require some medium for their propagation. So we can say that sound waves are mechanical waves.

Propagation of sound – Experiment:

- Place a **bell jar** on vacuum pump.
- Suspend an **electric bell** in it with the help of two wires.
- Fix a **cork** in the mouth of bell jar.
- On **ringing** the bell sound can be **heard.**
- Now start **expelling the air** form jar by vacuum pump.
- The sound becomes **faint** and **faint.**
- At last sound become **hardly heard**.
- By this experiment it has proved that **medium is necessary** for propagation of sound waves.

Write down the characteristics of sound?
There are following characteristics of sound: -

i) Loudness: -

It is a characteristic of sound by which **loud and faint sounds** can be distinguished.

Loudness of sound **depends upon following factors**: -

d. Amplitude of Vibrating Body: -

- If **amplitude** of vibrating body is **large** then **loud** sound will be produced and if **amplitude is small then** faint sound will be produced
- e.g. when we strike the drum forcefully loud sound will be produced due to large amplitude.

e. Area of Vibrating Body: -

- If the area of vibrating body is larger then loud sound will produced and if the area of vibrating body is small then faint sound will produced
- e.g. sound produced by larger drum will be loud then a small drum.

f. Distance from vibrating body: -

- Loudness of sound also depends upon the distance between producer and listener.
- Greater distance between them result in faint sound.
- Less distance between them results in loud sound.

ii) Intensity of Sound: -

- **Sound energy flowing per second through a unit area** held perpendicular to the direction of sound waves is called the intensity of sound.
- It is **physical quantity** and does not depend on the condition of ear.

iii) Pitch of Sound: -

- The characteristic of sound by which a **shrill sound and grave sound** can be distinguished.
- Higher pitch shows lower frequency.
- Frequencies of voices of ladies and children are greater and their voice is shrill.
- The frequencies of old men are lesser and their sound is grave.

iv) Quality of Sound: -

The characteristics of sound by which **two sounds of same loudness and pitch** can be distinguished.

v) Noise & Music: -

- The sound, which has **pleasant effect** on our ears, is called Music.
- The sound, which produces **jarring effect** on our ears, is called noise.

NUMERICAL PROBLEMS

Q.11.1 A normal conversation involves sound intensities of about 3.0×10^{-6} Wm^{-2}. What is the decibel level for this intensity? What is the intensity of the sound for 100dB?

Solution: ***Given Data:***

Intensity of sound is $I = 3.0 \times 10^{-6}\ Wm^{-2}$

We know Intensity level $= K \log(\frac{I}{I_o})$ B $= 10 \log \frac{I}{I_o}$ dB....(1)

(Where $I_o = 10^{-12}\ Wm^{-2}$ & 1 Bell = 10 dB)

Putting values in eq. no. 1 we get: Intensity level $= 10 \log \frac{3.0 \times 10^{-6}}{10^{-12}}$ dB

Intensity level $= 10 \log (3.0 \times 10^{6})$ dB

We know $\log(ab) = \log a + \log b$

Intensity level $= 10 (\log 3 + \log 10^{6})$ dB

Intensity level $= 10 (0.48 + 6)$ dB

Intensity Level $= 64.8$ dB

Sound level = 100 dB

Intensity level/ Sound level $= 10 \log \frac{I}{I_o}$ dB....(1) (Where $I_o = 10^{-12}\ Wm^{-2}$)

$$100\ dB = 10 \log \frac{I}{10^{-12}}\ dB$$

$$= \quad 10 = \log \frac{I}{10^{-12}}$$

Taking anti log by sides we get: $10^{10} = \frac{I}{10^{-12}} = I = 10^{10-12}$

$$I = 0.01\ Wm^{-2}$$

Q.11.2 If at Anarkali bazar Lahore, the sound level is 80 dB, what will be the intensity level of sound there?

Solution: Given Data:

Sound level = 80 dB

Intensity level/ Sound level $= 10 \log \frac{I}{I_o}$ dB....(1) (Where $I_o = 10^{-12}\ Wm^{-2}$)

$$80\ dB = 10 \log \frac{I}{10^{-12}}\ dB$$

$$8 = \log \frac{I}{10^{-12}}$$

Taking anti log we get: $10^{8} = \frac{I}{10^{-12}} = I = 10^{8-12}$

$$I = 10^{-4}\ Wm^{-2}$$

Q.11.3 At a particular temperature, the speed of sound in air is 330ms^{-1}. If the wavelength of a note is 5 cm, calculate the frequency of the sound wave. Is this frequency lies in the audible range of the human ear?

Solution: Given Data: Data in SI unit:

The speed of sound $v = 330\ ms^{-1}$ $v = 330\ ms^{-1}$

Wavelength of note is $\lambda = 5$ cm $\lambda = 0.05$ m we know 1m =100cm

Frequency of note is f = ?

We know the relation between v, f & λ is

$$f\lambda = v \text{ ....(1)}$$

$$\Rightarrow \quad f = \frac{v}{\lambda}$$

Putting values we get : $f = \frac{330}{0.5} = 6.6 \times 10^3 Hz$

Yes this frequency lies in the audible range of human ear.

Q.11.4 A doctor counts 72 heart beats in 1 min. Calculate the frequency and period of the heartbeats.

Solution: Given Data:

Number of counts n =72

Time t = 1min. = 60 sec.

$$f = \frac{\text{number of beats}}{\text{time}}$$

Putting values we get: $f = \frac{72}{60} = 1.2$ Hz

We know $fT = 1 \Rightarrow T = \frac{1}{f}$

$$T = \frac{1}{1.2} = 0.83 \text{ sec.}$$

Q.11.5 A marine survey ship sends sound wave straight to the sea bed. It receives an echo 1.5 s later. The speed of sound in sea water is 1500 ms^{-1}. Find the depth of the sea at this position.

Solution: Given Data:

Let the distance between the surface and seabed is = d m

(Echo heard after time) t = 1.5

The speed of sound $v = 1500\ ms^{-1}$

Using the formula: d = v t ....(1)

For echo sound waves travel the total distance d + d = 2 d

It becomes 2d = v t

Putting value we get: 2d = (1500)×(1.5)

d = 1125 m

Q.11.6 A student clapped his hands near a cliff and heard the echo after 5 s. What is the distance of the cliff from the student if the speed of the sound, v is taken as 346 ms^{-1}?

Solution: *Given Data:*

Let the distance between the cliff and student is "d" meters.

(Echo heard after time) t = 5 Sec.

The speed of sound v = 346 ms^{-1}

We know the relation: $d = v\,t$........ (1)

For echo sound waves travel the total distance $d + d = 2\,d$

put in equation no. 1 we get:

$$2\,d = (346) \times (5)$$
$$2\,d = 1730$$
$$d = 865\text{ m}$$

Q.11.7 A ship sends out ultrasound that returns from the seabed and is detected after 3.42s. If the speed of ultrasound through seawater is 1531 ms^{-1}, what is the distance of the seabed from the ship?

Solution: *Given Data:*

Let the distance between the ship and seabed "d" meters.

(Echo detected after time) t = 3.42 Sec.

The speed of sound in water is v = 1531 ms^{-1}

We know the relation: $d = v\,t$........ (1)

Ultra-sound travels the total distance $d + d = 2\,d$

put in equation no. 1 we get:

$$2\,d = (1531) \times (3.42)$$
$$2\,d = 5236.02$$
$$d = 2618\text{ m}$$

Q.11.8 The highest frequency sound humans can hear is about 20,000 Hz. What is the wavelength of sound in air at this frequency at a temperature of 20° C? What is the wavelength of the lowest sounds we can hear of about 20 Hz? Assume the speed of sound in air at 20° C is 343 ms^{-1}.

Solution: *Given Data:*

Highest frequency f_m = 20,000 Hz & Lowest frequency f_L = 20 Hz

The speed of sound v = 343 ms^{-1}

We know the relation: $f\lambda = v$........ (1)

When frequency is high, wavelength will be low but the product will be the same equal to the speed of sound waves.

We can say: $f_m \lambda_L = v$ This implies $\lambda_L = \frac{v}{f_m}$

Putting values we get: $\lambda_L = \frac{343}{20000}$

$\lambda_L = 0.017\text{ m} = 1.7 \times 10^{-2}\text{ m}$

We can say: $f_L \lambda_m = v \;=\; \lambda_m = \frac{v}{f_L}$

Putting values we get: $\lambda_m = \frac{343}{20}$

$\lambda_m = 17.2$ m

Q.11.9 A sound wave has a frequency of 2 kHz and wavelength 35 cm. How long will it take to travel 1.5 km?

Solution: ***Given Data:***

Frequency $f = 2$ kHz $= 2000$ Hz	we know 1 kHz = 1000 Hz
Wavelength $\lambda = 35$ cm $= 0.35$ m	we know 1 m = 100 cm
Time $t = ?$	
If distance $d = 1.5$ Km $= 1500$ m	we know 1 km = 1000 m

We know the relations $f\lambda = v$ & $d = v\,t$

First we find the speed of sound waves $v = f\lambda$

Putting values we get: $v = (2000)\times(0.35)$

$v = 700\text{ms}^{-1}$

To find time, we use the relation $d = v\,t$

$\Rightarrow t = \frac{d}{v}$

Putting values $t = \frac{1500}{700} = 2.1$ sec.

SHORT QUESTIONS

What do you understand by the reflection of light? Draw a diagram to illustrate reflection at a plane surface.

When light ray is completely returns back into some medium after falling from a polished surface is called "reflection of light"

Describe the following terms used in reflection.

Normal:

The perpendicular drawn on the reflecting plane, at point of incidence of ray of light as called "normal".

Angle of Incidence:

The angle between incident ray and normal is called angle of incidence.

Angle of reflection:

The angle between reflected ray and normal is called angle of reflection.

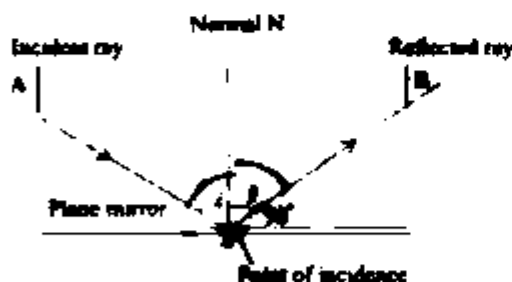
State laws of reflection. Describe how they can be verified graphically.

1st Law:

It states that angle of incidence is equal to angle of reflection.

<AON = <ONB = <i = <r

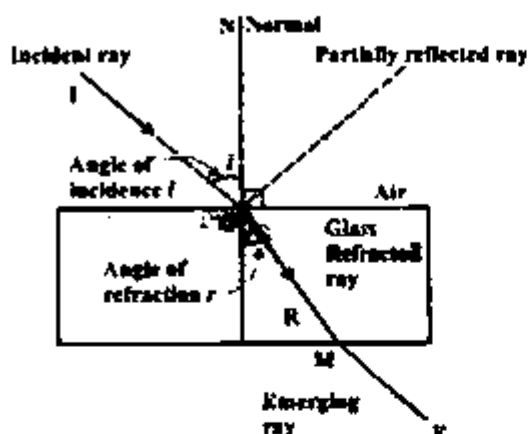
2nd Law:

It states that incident ray, reflected ray and normal lie in the same plane.

Define refraction of light. Describe the passage of light through parallel sided transparent material.

The bending of light rays coming from one medium and enters into another medium. This property of light is called "refraction" of light.

Explanation:

Consider a slab of glass (parallel sided transparent material) as shown in figure below:

A ray of light IQ travelling from air falls on the surface of a glass block.

At air-glass interface, the ray of light IQ changes its direction and bends toward the normal and travels along the path OR ray inside the glass block. The rays IQ and OR are called incident and refracted ray respectively.

Angle of incidence:

The angle <i made by incident ray with normal is called angle of incidence.

Angle of refraction:

The angle <r made by refracted ray with normal is called angle of refraction.

Normal:

The refracted light my leaves the glass it bends away from the normal and travels along the path ME. It is called **emergent ray**.

State the laws of refraction of light an show how they may be verified using rectangular glass slab and pins.

1st Law:

Lt states that incident ray, normal and refracted rays lie in same plane.

2nd Law:

It states that ratio of sine of angle of incidence to the sine of angle of refraction is constant (Snell's law)

What is meant by the term total internal refection?

When a light ray is incident upon the separating surface, coming from denser medium for which angle of reflection in rare medium is greater than 90º then it is called total internal reflection.

State the condition for total internal reflection?

i) The incident ray should come from denser medium at angle of incidence greater then critical angle.
ii) The totally reflected ray is received in the same denser medium.

What is critical angle? Derive a relationship between the critical angle and the refractive index of a substance.

Critical Angle:

The angle of incidence in the denser medium for which corresponding angle of refraction is 90^0 in the rarer medium is called the critical angle. This angle of incidence is denoted by C.

Relationship between Critical Angle and Refractive Index:

Let's say that the less dense medium is air (n=1). Then the refractive index of the second medium is:

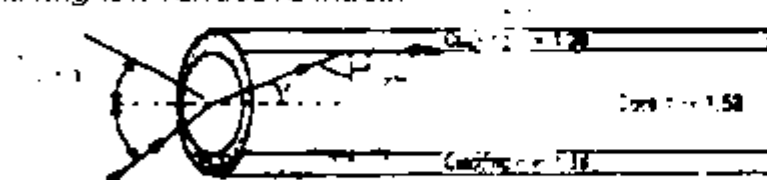
n = sin i /sin r
  = sin 90° / sin c
n = 1 / sin c

So, REFRACTIVE INDEX:
n = 1 / sin c or 1 divided by sin c
c = critical angle for the medium

What are optical fibers? Describe how total internal reflection is used in light propagating through optical fibers.

Optical Fiber is a strand of glass or plastic not much thicker than human hair uses light signals to transfer information from one end to other.

Explanation:

The central part of the optical fiber is made up of glass or plastic having relatively high refractive index called cone through which light travels. The core is surrounded by a coaxial layer of glass (with small index of refraction) or plastic called cladding having low refractive index.

As shown in figure the light entering the optical fiber strikes the cladding with an angle greater than the critical angle of the glass it is totally reflected into the core. In this way light travels many kilometers with small loss of energy.

Define the following terms applied to a lens:

Principal axis:

The line passing through pole and focal point is called principle axis of lone.

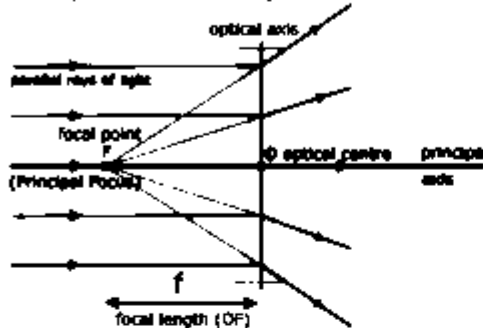
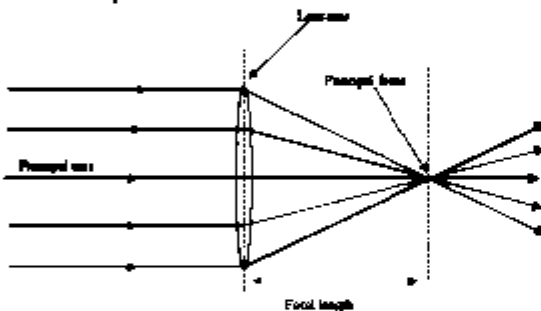
Optical centre:

The central symmetric point of a lens is called optical centre.

Focal length:

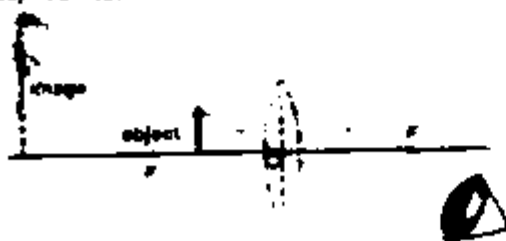
The distance between focal point and optical centre of lens is called its focal length.

What is meant by the principal focus of a (a) convex lens (b) a concave lens? Illustrate your answer with my diagrams

In **concave mirror** rays of light parallel to the principal axis after reflection converge to a point F. This point is called Principal Focus.

In **convex mirror**, rays parallel to the principal axis after reflection appear to come from a point F situated behind the mirror. This point is called Principal Focus.

Describe how light is refracted through convex lens.

Convex lens bends the light towards the principal axis that is towards thickest part of the lens after refraction.

With the help of a ray diagram, how you can show the use of thin converging lens as a magnifying glass.

If object is placed at between optical point and F, the image is formed behind the object, virtual, erect and larger than the object.

A coin is placed at a focal point of a converging lens. Is an image formed? What is its nature?

If a coin (object) is placed at a focal point of a converging lens its image is not formed because rays become parallel after passing through the lens.

What are the difference between real and virtual images?

Real image is that image which can be formed on a screen but the virtual image cannot formed on a screen.

How does a converging lens form a virtual image of a real object? How does a diverging lens can form a real image of a real object?

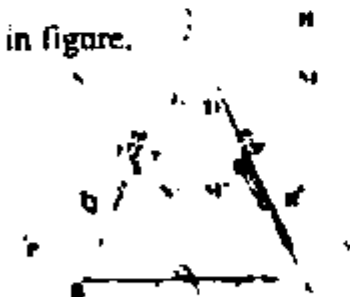
In case of converging lens: A virtual image is formed of a real object when it is placed between the focal point and optical centre of the lens.

Define power of a lens and its units.

The power of a lens is the reciprocal of focal length in meters. The SI unit of power is called diopter, represented as D. The power of a lens with (f = 1m) is said to be one diopter.

P = 1/f

Define the passage of light through a glass prism and measure the angle of deviation.

Prism is a transparent and refracted medium made up of optical glass with at least two polished plane faces inclined towards each other from which light is refracted. A triangular prism is shown in figure below:

According to the law of refraction n = Sin i / Sin r

The incident ray PE makes an angle of incidence <i at point B and is refracted towards the normal N as BF. The refracted ray makes an angle of refraction <r inside the prism and travels to the other end of the prism.

This ray emerges out from the prism at point P making an angle e. Hence the emerging ray FS is not parallel to the incident ray EF but it is deviated by an angle D which is called **angle of deviation**.

Define the terms resolving power and magnifying power.

Resolving Power:

The resolving power of an instrument is its ability to distinguish between two closely placed objects or point sources. For example we use high resolving power microscope to see tiny organisms and telescope to view distant stars.

Magnifying Power (Angular Magnification:

The magnifying power is defined as "The angular size θ of the final image produced by the magnified glass divided angular size θ of the final image produced by the magnified glass divided the angular size θ of the object seen without the magnifying glass.

What is light? How non-luminous objects can be seen?

Light is a form of energy that gives the sensation of vision. Light is the electromagnetic radiations. When light from a source falls on a non-luminous object then it is reflected, refracted or absorbed. This light received in the eyes of observer and give sense of observation of object.

What is reflection of light? What are its types?

The bouncing back of light into same medium is called reflection of light. It has two types:-

Regular reflection:

It occurs when light is reflected through smooth surface.

Diffused or Irregular reflection:

It occurs when light is reflected through irregular surface.

Define spherical mirror. What are their types?

The minor made up of a pan of surface of a hallow sphere of glass/plastic is called "spherical mirror". There are two types of spherical minors.

Concave Spherical mirror:

The spherical mirror having its inner reflecting surface is called concave spherical mirror. Rays parallel to principal axis after reflection pass through the focal point. Both real and virtual images can be formed by ths type of mirror.

Convex Spherical mirror:

The spherical mirror having its outer reflecting surface is called convex spherical mirror. Rays parallel to principal axis after reflection seem to be coming from the focal point. Only virtual and erect images is formed by a convex mirror.

Explain different type of technologies used in case of spherical mirrors.

Center of curvature (C):

The center of the hollow sphere a part of whose surface is used to make spherical mirror is called center of curvature.

Radius of curvature (R):

The radius of hollow sphere, a part of whose surface is used to make a spherical mirror is called "radius of curvature" of the mirror.

Aperture:
The length of straight line which divides the spherical mirror into two equal parts is called diameter or aperture of mirror.

Pole / Vertex:
The central symmetrical point of a spherical mirror is called pole of mirror. It is also called vertex.

Principle axis:
The straight line passing through principle focus and pole of spherical mirror is called its principle axis.

Principle focus:
The point at which parallel incident rays, after reflection from spherical mirror converge (or appear to converge) is called its principle focus.

Focal length:
The distance from "pole" to principle focus of a spherical mirror is called its focal length. For concave mirror it is taken as positive and for convex mirror it is taken as negative.

What is the relationship between focal length and radius of curvature?
The focal length is related to the radius of curvature by $f = R/2$

What is corpuscular nature of light?
In the early 1700s, there were two ideas about the nature of light. Particle nature and Wave nature. Newton put forward the idea of corpuscular nature of light. According to him light consists of tiny fast moving particles. Maxwell formulated the wave theory of light. In I802, Thomas Young proved the wave nature of light experimentally. In 1900 Planck suggested that light consists of small packets of energy called photon. Later on idea of photon was confirmed by experiments. Now we know that light dual nature. Light as well as Particle nature.

What is mirror equation and give its sign convention?
Mirror formula is the relation between object distance p, image distance q from the mirror and focal length of the mirror. We can write this:

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

It is required formula for concave / convex mirror.
Sign Conventions:

- Focal length f is positive for concave mirror and negative for convex mirror.
- Object distance p is positive for real object and negative for virtual object.
- Image distance q is positive for real image and negative for virtual image.

Define magnification of spherical mirrors.
Definition of magnification is that "how many times the size of image formed by spherical mirror is greater than the size of object". Mathematically we write

$$\text{Magnification} = \frac{\text{Size of image}}{\text{Size of object}} = m = \frac{h_i}{h_o}$$

What is total internal reflection of light? What are its conditions?

When angle of incidence becomes larger than the 'critical angle, no refraction occurs. The entire light is reflected back into same denser medium. This process is called total internal reflection.

Conditions:

- When light ray is travelling from a glass (denser medium) to air (rare medium). The light my bends away from normal. If the angle of incidence increases then angle of refraction also increases.
- At some particular angle of incidence at which the 'angle of refraction becomes 90° is called "critical angle". It is denoted by θ_c.
- Light ray should be incident from denser.
- Angle of incidence (in denser medium must be greater than θ_c)

What are totally reflecting prism and periscope.

Consider a right-angled prism whose one of the angles is 90° and other angles are 45° each. When a light ray strikes a face of prism perpendicularly, it enters the prism without deviation and strikes the hypotenuse at an angle of 45°. Since the angle of incidence 45° greater than the critical angle of the glass which in 42° , the light is totally reflected by the prism through an angle of 90°

Periscope:

Two such prisms (totally internal reflecting) are used in periscope. The light is totally reflected by an angle of 180°.

What is mirage? Explain.

The mirage is formed by the process of total internal reflection. The rays of light coming from upper layers cooler layer of air (denser) and enter into lower hotter layers of air (rare). Then these lays bend away from normal because hotter layers of air are less dense than cooler layers. When thin process continues in the layer by layer, then light is ultimately suffers total internal refraction and an inverted image of trees or buildings is observed on roads. It is called **mirage**.

What is Lens? What are its types?

The piece of transparent refracting medium, whose boundary surface has some part of spherical shape is called lens. It has 6 types:

Plano-convex	Double convex	Concave-convex
Plano concave	Double concave	Convexo concave

What are the three rays used for the formation of images in case of lenses?

- The ray parallel to the principal axis passes through the focal point after refraction by the lens.
- The ray passing through the optical centre passes straight through the lens and passes un-deviated.
- The ray passing through the focal point becomes parallel to the principal axis after refraction by the lens.

LONG QUESTIONS

Write notes on the followings.

Light pipe:

Light pipe is bundle of thousands of optical fibers bounded together. They are used to illuminate the inaccessible places by the doctors and engineers. For example doctors view inside the human body. It can be used to transmit images from one place to another.

Endoscope:

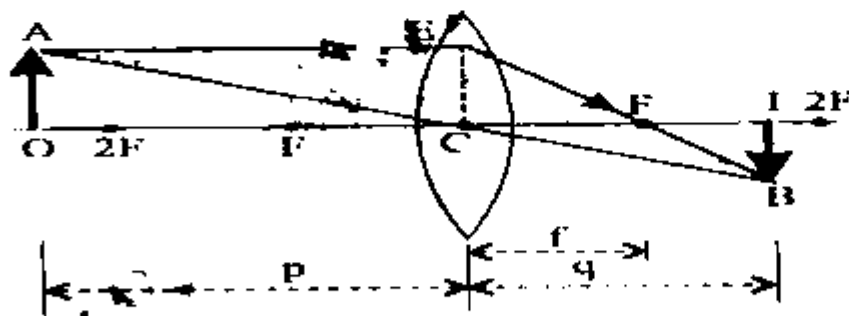
An endoscope is a medical instrument used for diagnostic surgical purposes. An endoscope uses two optical fibers tubes through a pipe.

Process of Endoscope:

Due to small size it is inserted through the mouth and thus eliminates the invasive surgery. The light shines on the organ of patient to be diagnosed while entering through one of the fiber tubes of the endoscope. Then light is transmitted back to physician's viewing lens through the other fiber tube by total internal reflection. Flexible endoscope has a tiny camera attached to the end. Doctor can see the view recorded by the camera is displayed on a computer screen.

A medical procedure using any type of endoscope is called **endoscopy**. For example **Gastroscopy**, **Cystosopy** and **Bronchoscopy** means endoscope is used to diagnose stomach, bladder and throat respectively.

>> Question: Derive the convex lens formula?

Consider the following figure:

i) An object OA, is placed in front of a thin convex lens.
ii) A ray of light starting from point 'A', moving parallel to the principal axis strikes the lens at the point 'E'.
iii) After refraction through the lens, it passes through the principal pocus F.
iv) A second ray AC also starting from 'A' passes through the optical centre of the lens and moves straight (un-deviated) and intersects the first refracted ray at the point 'B'.
v) Thus 'B' is the real image of point 'A'.

vi) If this process is repeated for other points of the objects OA then a real image IB of the object OA is obtained.

vii) Distance of the object from the lens is represented by p and that of image by q. ΔOAC and ΔIBC are similar because angle ACO = angle BCI. Also one angle in each triangle is 90^0.

$$\frac{AO}{BI} = \frac{OC}{CI} \quad \text{------------------------ (i)}$$

Similarly, ΔEFC and ΔBFI are similar.

$$\frac{CE}{BI} = \frac{CF}{FI}$$

$$EC = AO$$

$$\frac{AO}{BI} = \frac{CF}{FI} \quad \text{------------------------ (ii)}$$

Comparing Equation (i) and Equation (ii) we get,

$$\frac{OC}{CI} = \frac{CF}{FI} \quad \text{(As we know CI - CF)}$$

$$\frac{OC}{CI} = \frac{CF}{CI - CF}$$

Now CI=q, OC=p and CF =f

$$\frac{p}{q} = \frac{f}{(q - f)}$$

$$fq = p (q - f)$$

$$fq = pq - pf$$

Dividing both sides by pqf, we get

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

==

What is Accommodation with respect to human eye? Explain.

The variation of focal length of human eye lens is called accommodation. The human eye has different mechanism for focusing the image of an object onto the retina. Its ciliary muscles control the curvature and thus the focal length of the lens and allow the object at various distances tc be seen.

- If the object is far away from the eye the deviation of light through the lens must be less. To do this, the ciliary muscles relax and decrease the curvature of the lens so by increasing the focal length. The rays focus on retina producing a sharp image of the distant objects.
- If the object is close to the eye, the ciliary muscles increases the curvature of the lens so by shorting the focal length. The divergent rays from the nearer object are thus bent more so as to come to a focus on the retina.

Write a note on human eye. Also describe Near Point & Far Point.

Human eye has a refracting system having a converging lens that forms an image on the retina which is a light sensitive layer at the back of the eye as shown in the following diagram. The lens of the eye is flexible and accommodates objects over a wide range of distance.

Cornea:

Light enters the eye through a transparent membrane called cornea.

Iris:

Iris is the colored portion of the eye and it controls the amount of light reaching the retina. It has a opening at its center called the pupil. The Iris control the size of pupil. In bright light it contracts and in dim light it enlarged.

Near Paint / Least distance of distinct vision:

The near point of the eye is the minimum distance of an object from the eye at which it produces a sharp image on the retina. This distance is also called least distance of distinct vision. Its value for norm al aye is 25 cm.

Far Point:

The far point of the eye is he maximum distance of a distant object from the eye or which the fully relaxed eye can focus. A person with normal eyesight can see objects very far away such as planets and stars.

What the defects of vision?

Near sightedness / Short-sight / Myopia:

- If a person cannot see distant objects clearly without aid of spectacles, this defect is known as short-sight or near-sightedness.
- It is due to the eyeball is too long that the light rays from a distant object are focused in front of retina and a blurred image is produced.
- This defect is removed with glass or contact lenses that use diverging lenses. Light rays from the distant objects are now diverged by this lens before entering the eye. For observer these rays appear to come from far point and therefore focused on the retina forming sharp image.

Far-sightedness / Hypermetropia:

- If a person cannot see nearby objects clearly without aid of spectacles. This defect is known as farsightedness.
- When a person with farsightedness defect tries to focus on a book held closer than the near point, it shortens the focal length as much as it can. However at its shortest the focal length is longer than it should be. Therefore the light rays from book would form image behind the retina.
- This defect is removed with glass or contact lenses that use converging lenses. The lens refracts the light rays and they converge to form an image on the retina. To the observer these rays appear to come from the near point to form sharp and virtual image on the retina.

NUMERICAL PROBLEMS

Q.12.1 An object 10.0 cm in front of a convex mirror forms an image 5.0 cm behind the mirror. What is the focal length of the mirror

Solution: ***Given Data:***

Object distance $p = 10.0$ cm

Image distance $q = -5.0$ cm (Image is virtual, behind the mirror, so taken as negative)

Find focal length $f = ?$

We know the mirror equation:

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

Putting values we get $\frac{1}{f} = \frac{1}{10} + \frac{1}{-5}$ $\frac{1}{f} = \frac{1}{10} - \frac{1}{5}$

$$\frac{1}{f} = \frac{1-2}{10}$$

$$\Rightarrow \quad f = -10 \text{ cm}$$

The focal length is negative due to convex mirror.

Q.12.2 An object 30.0 cm tall is located 10.5 cm from a concave mirror with focal length 16.0 cm. (a) Where is the image located? (b) How high is it?

Solution: ***Given Data:***

Object height $O = 30.0$ cm

Object distance $p = 10.5$ cm

Focal length $f = 16.0$ cm

Image distance $q = ?$ & Image height $I = ?$

We know the mirror equation: $\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$

Arranging for "q" $\frac{1}{q} = \frac{1}{f} - \frac{1}{p}$

Putting values we get: $\frac{1}{q} = \frac{1}{16} - \frac{1}{10.5}$

$$\frac{1}{q} = \frac{10.5-16}{16 \times 10.5}$$

$$q = -\frac{168}{5.5}$$

$$q = -30.54 cm$$

The negative sign shows that the image is virtual and forms behind the mirror.

We know the equation: Magnification $= \frac{I}{O} = \frac{q}{p}$

$$I = \frac{q}{p} \times O$$

Putting values we get: $I = \frac{30.54}{10.5} \times 30.0$

$$I = 87.26\ cm$$

Q.12.3 An object and its image in a concave mirror are of the same height, yet inverted, when the object is 20.0 cm from the mirror. What is the focal length of the mirror?

Solution: ***Given Data:***

Object height = Image height $\Rightarrow O = I$

Object distance p = 20.0 cm

Focal length $f = ?$

Magnification $= \frac{I}{O} = \frac{q}{p}$ Given I = O Hence $\frac{q}{p} = 1 \Rightarrow q = p$

We know the mirror equation: $\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$

Putting values we get: $\frac{1}{f} = \frac{1}{p} + \frac{1}{p}$

$$\frac{1}{f} = \frac{2}{p} \quad \Rightarrow f = \frac{p}{2}$$

$$f = \frac{20}{2} \quad \text{Hence } f = 10\ cm$$

Q.12.4 Find the focal length of a mirror that forms an image 5.66 cm behind a mirror of an object placed at 34.4 cm in front of the mirror.

Solution: ***Given Data:***

Object distance p = 34.4 cm

Image distance q = - 5.0 cm (Virtual, behind the mirror, so taken as negative)

Find focal length $f = ?$

We know the mirror equation: $\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$

Putting values we get: $\frac{1}{f} = \frac{1}{34.4} + \frac{1}{-5.66}$

$$\frac{1}{f} = \frac{1}{34.4} - \frac{1}{5.66}$$

$$\frac{1}{f} = \frac{5.66 - 34.4}{34.4 \times 5.66}$$

$$\frac{1}{f}=-\frac{28.74}{194.7}$$

$$\Rightarrow \quad f=-6.77\,cm$$

The negative sign shows that it is convex mirror.

Q 12.5 ... tatue appears to be 11.5 cm behind a convex mirror with focal length 13.5 cm. Find the distance from the statue to the mirror.

Solution: *Given Data:*

Focal length $f = -13.5$ cm (Focal length is negative for convex mirror)

Image distance $q = 11.5$ cm

Object distance $p = ?$

We know the mirror equation: $\frac{1}{f}=\frac{1}{p}+\frac{1}{q}$

Arranging for "p" $\frac{1}{p}=\frac{1}{f}-\frac{1}{q}$

Putting values we get: $\frac{1}{p}=\frac{1}{-13.5}-\frac{1}{11.5}$

$$\frac{1}{p}=-\frac{1}{13.5}-\frac{1}{11.5}$$

$$\frac{1}{p}=\frac{-11.5-13.5}{13.5\times11.5}$$

$$\Rightarrow \quad p=-\frac{155.25}{25}$$

$$\Rightarrow \quad p=-6.2\,cm$$

Q 12.6 An image is produced by a concave mirror of focal length 8.70 cm. The object is 13.2 cm tall and at a distance 19.3 cm from the mirror. (a) Find the location and height of the image. (b) Find the height of the image produced by the mirror if the object is twice as far from the mirror.

Solution: *Given Data:*

Focal length $f = 8.70$ cm

Object height O = 13.2 cm

Object distance p = 19.3 cm

(a) Find image distance q = ? & Image height I = ?

(b) Find image height I' = ? If p' = 2p

We know the mirror equation: $\frac{1}{f}=\frac{1}{p}+\frac{1}{q}$

Arranging for "q" $\frac{1}{q}=\frac{1}{f}-\frac{1}{p}$

Putting values we get: $\frac{1}{q}=\frac{1}{8.7}-\frac{1}{19.3}$

$$\frac{1}{q}=\frac{19.3-8.7}{8.7\times19.3}$$

$$q=\frac{167.91}{10.6} \Rightarrow q=15.84\,cm$$

$$\text{Magnification}=\frac{I}{O}=\frac{q}{p} \Rightarrow I=\frac{q}{p}\times O$$

Putting values we get: $I=\frac{15.84}{19.3}\times13.2=\frac{208.56}{19.3}$

$$I=10.8\,cm$$

(b) Find image height I' = ? If p' = 2p

We know $\frac{I}{O}=\frac{q}{p} \Rightarrow I'=\frac{q}{p'}\times O$

Putting values we get: $I'=\frac{q}{2p}\times O=\frac{1}{2}(\frac{q}{p}\times O)$

$$I'=\frac{1}{2}(\frac{q}{p}\times O)=\frac{1}{2}I$$

$$I'=\frac{1}{2}\times10.8=5.4\text{ cm}$$

Q.12.7 Nabeela uses a concave mirror when applying makeup. The mirror has a radius of curvature of 38.0 cm. (a) What is the focal length of the mirror? (b) Nabeela is located 50 cm from the mirror. Where will her image appear? (c) Will the image be upright or inverted?

Solution: *Given Data:*

Radius of curvature R = 38.0 cm So Focal length $f = R/2 = 19.0$ cm

Object distance p = 50 cm

(a) Find image distance q = ? & it nature = ?

We know the mirror equation: $\frac{1}{f}=\frac{1}{p}+\frac{1}{q}$

Arranging for "q" $\frac{1}{q}=\frac{1}{f}-\frac{1}{p}$

Putting values we get: $\frac{1}{q}=\frac{1}{19}-\frac{1}{50}$

$$\frac{1}{q}=\frac{50-19}{19\times50}$$

$q=\frac{950}{31}=30.64$ cm The image is upright.

Q.12.8 An object 4 cm high is placed at a distance of 12 cm from a convex lens of focal length 8 cm. Calculate the position and size of the image. Also state the nature of the image.

Solution: *Given Data:*

Object height O = 4 cm
Object distance p = 20 cm
Focal length of convex lens f = 8 cm
Find image distance q = ? & it height I = ?

We know the lens equation: $\frac{1}{f}=\frac{1}{p}+\frac{1}{q}$

Arranging for "q" $\frac{1}{q}=\frac{1}{f}-\frac{1}{p}$

Putting values we get: $\frac{1}{q}=\frac{1}{8}-\frac{1}{12}$

$\frac{1}{q}=\frac{12-8}{8\times12}$

$q=\frac{96}{4} \Rightarrow q = 24\text{ cm}$

Magnification $=\frac{I}{O}=\frac{q}{p} \Rightarrow I=\frac{q}{p}\times O$

Putting values we get: $I=\frac{24}{12}\times4 \Rightarrow I=8\ cm$

The image is real, inverted and magnified.

Q.12.9 An object 10 cm high is placed at a distance of 20 cm from a concave lens of focal length 15 cm. Calculate the position and size of the image. Also state the nature of the image

Solution: *Given Data:*

Object height O = 10 cm
Object distance p = 20 cm
Focal length of convex lens f = -15 cm (Negative for concave lens)

Find image distance q = ? & it height I = ?

We know the lens equation: $\frac{1}{f}=\frac{1}{p}+\frac{1}{q}$

Arranging for "q" $\frac{1}{q}=\frac{1}{f}-\frac{1}{p}$

Putting values we get: $\frac{1}{q}=\frac{1}{-15}-\frac{1}{20}$

$$\frac{1}{q} = \frac{-20-15}{15\times 20}$$

$$\Rightarrow \quad q = -8.57\text{cm}$$

Magnification = $\frac{I}{O} = \frac{q}{p} \quad \Rightarrow \quad I = \frac{q}{p}\times O$

Putting values we get: $I = \frac{8.57}{20} \Rightarrow I = 0.42\text{cm}$

The image is virtual erect and diminished

Q.12.10 A convex lens of focal length 6 cm is to be used to form a virtual image three times the size of the object. Where the lens must be placed?

Solution: *Given Data:*

Focal length of convex lens f = 8 cm

Virtual image of Magnification = $\frac{I}{O} = \frac{q}{p}$ = 3 This implies q = 3p

Object distance p = ?

We know the lens equation: $\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$

Putting given condition we get: $\frac{1}{f} = \frac{1}{p} + \frac{1}{3p}$

$$\frac{1}{f} = \frac{3-1}{3p}$$

This implies $f = \frac{3p}{2} \quad \Rightarrow \quad p = \frac{2f}{3}$

$$p = \frac{2\times 6}{3} \Rightarrow p = 4\ cm$$

Q.12.11 A ray of light from air is incident on a liquid surface at an angle of incidence 35°. Calculate the angle of refraction if the refractive index of the liquid is 1.25. Also calculate the critical angle between the liquid air inter-face.

Solution: ***Given Data:***

Angle of incident $< i = 35^0$

Refractive index n = 1.25

According to Snell's law, we know

$$\frac{Sin\ i}{Sin\ r} = n \quad \Rightarrow Sin\ r = \frac{Sin\ i}{n}$$

Putting values we get: $Sin\ r = \frac{Sin 35^0}{1.25}$

$$< r = Sin^{-1}\left(\frac{0.57}{1.25}\right)$$

$$< r = Sin^{-1}(0.458)$$

$< r = 27.2^0$

For critical angle (< C), the light ray enters from liquid (n_1 = 1.25) to air (n_2 = 1)

Again Snell's law, $n_1 \, Sin\, C = n_2 \, Sin\, r$ $< i = < C$ (*critical* angle for $< r = 90^0$)

$\Rightarrow$ $1.25 \, Sin\, C = 1 \times 1$ (we know Sin $90^0 = 1$)

$\Rightarrow$ $< C = Sin^{-1}(1/1.25)$

$\Rightarrow$ $< C = Sin^{-1}(0.8)$

$\Rightarrow$ $< C = 53.13^0$

Q.12 12 The power of a convex lens is 5 D. At what distance the object should be placed from the lens so that its real and 2 times larger image is formed.

Solution: *Given Data:*

Power of a lens is P = 5 D (diopter)

Magnification M = 2 & Real image is formed

Object distance p = ?

We know $P = \frac{1}{f(m)} \Rightarrow f = \frac{1}{P} \Rightarrow f = \frac{1}{5} = 0.2$ m

$\Rightarrow f = 20$ m

Magnification = $2 = \frac{I}{O} = \frac{q}{p} \Rightarrow \frac{q}{p} = 2 \Rightarrow q = 2p$

We know the lens equation: $\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$

Putting given condition we get: $\frac{1}{f} = \frac{1}{p} + \frac{1}{2p}$

$\frac{1}{f} = \frac{2+1}{2p}$

$\Rightarrow p = \frac{3f}{2}$

Putting values we get: $p = \frac{3 \times 20}{2} \Rightarrow p = 30\,cm$

THEORY & SOLVED EXERCISE

How can you show by simple experiment that there are two types of electric charges?

- Take a plastic rod rubbed with fur and suspended horizontally.
- Bring another plastic rod already rubbed with fur close to the suspended rod.
- The suspended rods show repulsion. It means during rubbing they get same kind of charges.
- Now take a glass rod which is rubbed with silk.
- It is brought near another plastic rod (already rubbed with fur) and suspended.
- It also shows attraction.
- These two experiments confirm the presence of two

What is the method of charging bodies by electrostatic induction?

The process of charging an insulated conductor develops positive charge at one end and negative charge at the other end in the presence of a charged body is called **electrostatic induction**.

How does electrostatic induction differ from charging by friction?

- In case of electrostatic induction the body is not physically in contact with the other body to be charged.
- The charged body is brought near to the body to be charged.
- But in case of friction the surfaces of the two bodies are rubbed with each other, so there is mutual transfer of electrons.

What is gold leaf electroscope? Discuss as working principle with a label diagram.

An electroscope is an instrument used for detecting and testing the nature of charge on a body. One special type of electroscope is gold leaf electroscope.

Electroscope
Fig 15 3

Fig 15 4
If an object is uncharged, the leaves remain in normal position

Fig 15 5
The leaves diverge due to the presence of similar charge

Construction / Structure: -

i) It consists of a brass rod which has a brass disc connected to its upper end.
ii) Two very thin gold leaves are attached to its lower end.
iii) By the help of cork this assembly is mounted inside a glass jar with a brass disc projected outside.

iv) A thin foil of aluminium is pasted in the inner surface of jar.

Use/Working of Electroscope: -

i) First of all electroscope will have to be charged with +ev or −eve charge.
ii) In order to charge the electroscope positively, touch the disc with positively charged body and vice versa.
iii) In order to detect the presence of charge on a body bring it near the disc.
iv) If the divergence of leaves increases then the body has the same kind of charge as the electroscope carrying.
v) If the divergence of leaves decreases then the body has the opposite charge as the electroscope carrying.

Suppose you have a glass rod which becomes positively charged when you rub it with wool. Describe, how would you charge the electroscope i) negatively ii) positively?

- In order to produce positive charge on the electroscope, bring a negative charged rod near the disk of the electroscope.
- Positive charge will appear on the disk and negative chares will shift to the leaves.
- Now connect the disk of electroscope to the earthed aluminum foil by connecting wires.
- Charges of the leaves will flow to the earth through the wire.
- Now if we first break the earth connections and then remove the nod the electroscope will be left with positive charges.
- Similarly we can charge it negatively by using positively charged rod.

With the help of electroscope how you can find presence of charge on a body?

- If a neutral rod is brought near the disk of electroscope, there is no deflection on the leaves of the electroscope.
- When a positively or negatively charged rod is brought near the disk of electroscope then in either case the gold leaves diverge or distance between the two increases.

Describe how you would determine the nature of the charge on a body by using electroscope.

- We take a charged electroscope. The sign of charge positive or negative on its leaves is already known. Consider the electroscope is positively charged.
- Now a charged body is brought near the disk of the positively charged electroscope.
- If the divergence of the leaves increases then the body carries positive.
- On the other hand if the divergence decreases then the body carries negative charge.

What is meant by electric field and electric intensity?

- An **electric field** is the region around any electric charge **q** within which it can exert coulumb's force on any other electric charge when placed in it.

- The strength of electric field at any point in space is known as **electric field intensity**. It is represented by E.

Explain Coulomb's law of electrostatic and write its mathematical form?

- It states that the force of attraction or repulsion between two charges is directly proportional to product of the magnitudes of the point charges.
  Mathematically $F \alpha q_1q_2$
- And this force is inversely proportional to the square to the distance between these two charges.
  Mathematically $F \alpha 1/r^2$

  Combining these two facts we get

$$F \alpha q_1q_2/r^2$$

$$F = k \frac{q_1q_2}{r^2}$$

- The constant of proportionally K depends upon the nature of medium between the two point charges

Is electric intensity a vector Quantity? What will be its direction?

Electric intensity is a vector quantity.Its direction is the same as the direction of Coulomb's force.

Find the electric intensity due to a point charge q?

Consider a charge q is placed at a point, it is called field charge and a unit positive charge q_o experiences a force F when placed inside electric field of charge q.
Mathematically:
The force experienced by unit charge is = F / q_o

It is also known as value of electric field intensity $E = \frac{F}{q_o}$

How would you define potential difference between two points? Define its unit.

Electric potential at a point in electric field is equal to the amount of work done in bringing a unit positive charge from infinity to that point. Its unit is Volt.

One Volt:

The electric potential is said to be one volt, if one joule work work is done in brining a one coulomb positive charge.

Show that the difference can be described as energy transfer per unit charge between the two paints.

If W is the amount of work done in moving a charge q from infinity to a certain point against in the field. So that W/q = work done on unit charge.
It is converted into P.E. The electric potential is denoted by symbol V where V =W/q

This shows that "electric potential is equal to electric potential energy per unit charge. It is scalar quantity. Its SI unit is JC^{-1}. It is called Volt.

Describe capacitor as an energy staring device?

We define capacitor is a charge storing device but in actual it is energy storing device. In order to store the charge on a capacitor work is to be done, due to which electric potential is changed. So that energy is stored in the capacitor. The formula for the energy stored in a capacitor is given as $E = ½ CV^2$

Where C is the capacitance and V is the potential difference.

What do you mean by the capacitance of a capacitor? Define units of capacitance.

Capacitance of capacitor is the ability to store the charge. By the capacitor equation:

$Q = CV$, or $C = Q/V$

SI Unit of capacitance is "**farad**". One farad is the capacitance of that capacitor which can store an electric charge of one coulomb when the potential difference applied across the capacitor is one volt.

Derive the formula for the effective capacitance for a series combination of a number of capacitors.

- Each capacitor has the same charge across it.
  $Q = Q_1 = Q_2 = Q_3$
- The potential difference across each capacitor is different due to different values of the capacitances.
- The voltage V of the battery has been divided among the capacitors, we can write
  $V = V_1 + V_2 + V_3$ ………………………………… (1)
- The equations for three capacitors are
  $Q = C_1V_1 \quad = \quad V_1 = Q/C_1$
  $Q = C_2V_2 \quad = \quad V_2 = Q/C_2$
  $Q = C_3V_3 \quad = \quad V_3 = Q/C_3$
- Adding the above equations, we get
  $V = V_1 + V_2 + V_3$
  $V = Q/C_1 + Q/C_2 + Q/C_3$
  $V = Q(1/C_1 + 1/C_2 + 1/C_3)$
- The equation for the single equivalent capacitor is
  $Q = C_{eq}V \quad = \quad V = Q/C_{eq}$
- Putting value of V in equation (1)
  $Q/C_{eq} = Q(1/C_1 + 1/C_2 + 1/C_3)$

  $1/C_{eq} = 1/C_1 + 1/C_2 + 1/C_3$

Discuss different types of capacitors.

Paper Capacitor:

- Paper capacitor is an example of fixed capacitors.
- The paper capacitor has a cylindrical shape.

- Usually an oiled or greased paper or a thin plastic sheet is used as dielectric medium between the two aluminum foils.
- The paper or plastic sheet is firmly rolled in the form of cylinder and then it is closed into a plastic case.

Mica Capacitor:
- It is another example of fixed capacitor.
- In such kind of capacitor mica is used as dielectric between the two metal plates.
- Wires are projected out of the case for making connections.
- If the capacitance is to be increased large numbers of plates are piled up, one over the other.

Electrolyte Capacitor:
- Such capacitor is used to large amount of charge at relatively low voltage.
- It consists of a metal foil in contact with an electrolyte solution that conducts charge by virtue of the motion of the ions contained in it.
- When voltage is applied between the foil and the solution, a thin layer of metal oxide (an insulator) is formed on the foil, thus this layer serves as the dielectric

What is difference between variable and fixed type capacitor?

Fixed Capacitor:
The capacitor having the fixed capacitance. It is due to its constant area of storing the charge is called fixed Capacitor. For example paper and mica are fixed capacitors.

Variable capacitor:
In variable capacitors some arrangement is made to change the area of the plates facing each other.

Enlist some uses of capacitors.
Capacitors are widely used in electrical and electronic circuits. For example:
- They are used in tuning circuits of T.V. and radio in electric motors/fans etc.
- They are used in electronic circuits of computers etc.
- They are used to differentiate between high frequency and low frequency signals. They in used as filters in the circuits of rectifiers.
- The ceramic capacitors are true durable and an: superiors in their use.

Discuss one application of static electricity.
Static electricity has wide application in our daily life like photocopying, car painting and extracting dust from dirty capes and from chimneys of industrial machinery. One of them is give below.

Electrostatic Air Cleaner:
- An electrostatic air cleaner is used in homes to relieve the discomfort of allergy suffers.
- Air is mixed with dust and pollen enters the device names positively charged mesh semen.
- The airborne particles become positively charged when they make contact with the screen.
- Then they pass through a second negatively charged mesh screen.

- The electrostatic force of attraction between the positively charged particles in the air and negatively charged screen causes the particles to precipitate outer the mm of the screen.
- Through this process we can removes a very high percentage of contaminants from the air stream.

What are hazards of static electricity?

<u>Lightening:</u>

- The phenomenon of lightening occurs due to a large quantity of electric chare build up in the heavy thunderclouds.
- The thunderclouds are charged by friction between the water molecules in the thunderclouds and the air molecules.
- When the charge on the thunderclouds is sufficiently high.
- It can produce positive and negative charges in the air.
- The huge amount of negative charge is discharged to the highest object and on the ground and can harm them.
- That is why it is dangerous to swim in the open sea, play in an open ground during a thunderstorm.
- To prevent the tall building from damaging, lightening conductors are used.
- The purpose of this conductor is to provide discharge path to flow charges from air top of building to earth.

<u>Fires or Explosions:</u>

- A fire or explosion may occur due to excessive build-up of electric charge produced by friction.
- In case of fuel carrier (gasoline/petrol) truck gets charge through tires due to friction.
- This excess of charge can cause fire or explosion.
- To avoid such accident a conducting chain is suspended from the truck touching road.
- So the excess of charge flow to earth from the body of the truck.
- In case of aero plane, it gets charge on it due to air friction.
- There are quenching machines in the aero plane which neutralize the body of aero plane constantly.
- When the plane lands it is earthed to cause the flow of excess of charges to earth.

An electrified rod attracts pieces of paper. After a while these pieces fly away. Why?

When an electrified rod brings close to a piece of paper, opposite electric charges appear on piece of paper due to electrostatic induction. After attraction the positive charge body attracts the electrons from other so become neutral. Force finishes and paper flies away.

Written/Composed by: - SHAHZAD IFTIKHAR Contact # 0313-5665666
Website: www.downloadclassnotes.com , E-mail: raoshahzadiftikhar@gmail.com

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Define electric current.

The rate of flow of electric charge through any cross-sectional area is called electric current. If the charge Q is passing through an area A in time t second, then the current flowing through it will be I,

Current = charge/time

I = q/t

The unit of current is ampere in SI system.

Ampere:

One ampere is the amount of electric current due to the flow of electric charge at the rate of one coulomb per second.

What is meant by conventional current?

A current produced due to flow of negative charges is equivalent to a current due to flow of an equal amount of positive charge in opposite direction. This equivalent current of positive charge is known as conventional current.

Which type of charge is responsible for the flow of current in metallic conductors?

In metals or metallic conductors, the current is due to the flow of free electrons i.e. negative charges. For example in a copper wire there are large numbers of free electrons which are in random motion. When we apply potential difference across the wire, these free electrons move through the wire.

In electrolyte which charge are responsible for the flow of current?

The molecules of the electrolyte are dissolved among positive and negative ions in a solution. Thus current in electrolytes is due to the flow of both positive and negative charges.

How energy is obtained due to flow of charges.

When a positive charge moves from a point of higher potential to the point of lower potential, it gains the energy from the electric field. During flow of electric current, positive charges flow continuously from a high potential to a low potential point. Thus the electric current becomes a continuous source of energy.

How a galvanometer is converted into voltmeter?

The galvanometer is converted into voltmeter by connecting suitable resistance in series with it. The value of the resistance depends upon the range of the voltmeter. Usually its value is several thousand ohms. Thus the resistance of a voltmeter is very high.

How a galvanometer is converted into ammeter?

Galvanometer can be converted into an ammeter by connecting a small resistance parallel to it. This small resistance is known as "shunt". Shunt provides an alternative path for the current to flow. The major part of the current passes through the shunt and small fraction of it flows through the galvanometer.

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Why resistance of the ammeter is kept low?

If the resistance of the ammeter is kept high, then high amount of current flows through the galvanometer. When high amount of current will flow through the galvanometer then galvanometer can be burnt. That is why resistance of the ammeter is kept low.

Why resistance of the voltmeter is kept high?

If the resistance of the voltmeter is comparatively low, it will draw more current from the circuit. Due to this the potential difference across the resistance for the measurement, of which the voltmeter was connected, would drop.

On what factor reliability of voltmeter depend?

Higher the resistance of the voltmeter, more reliable would be its readings. Therefore a good voltmeter should have such a high resistance so that no or very little current could pass through it.

Differentiate between electromotive force and potential difference.

Electromotive Force:

The electromotive force of a battery or cell is the total energy supplied in driving one coulomb charge round a complete circuit in which cell is connected.

Potential Difference:

The potential difference determines the energy between any two points of the circuit which is required in moving a charge from one point to another.

State and explain Ohm's law. Write down its limitations.

The value of current I passing through a conductor is directly proportional to the potential difference V applied across its ends, provided the temperature and the physical state of the conductor does not change.

$V \propto I$

$V = IR$

Limitations:

Ohm's law is applicable only in case of metallic conductors when their temperature and physical state do not change.

Define resistance and its unit.

The property of a substance which opposes the flow of current through it is called its resistance.

$R = V/I$

S.I unit of resistance is Ohm.

Ohm:

If a current of one ampere passes through it when a potential difference of one volt is applied across its ends then resistance would be one Ohm. Ohm is usually represented by the Greek letter (Ω).

What are the factors upon which the resistance of u conductor depends?

- Length of the conductor (L)
- Area of cross-section of the conductor (A)
- Nature of the conductor
- Temperature.

Why does the resistance of a conductor increase with the rise of its temperature?

When the temperature of the conductor rises, average speed of the random motion of the free electrons increases which enhances the rate of collision of electrons and atoms. This causes an increase in the resistance of the conductor.

Why do we always use metal wires for conduction of electricity?

Because, they are good conductors of electricity and offer less resistance to the flow of current.

What do you mean by insulators?

The substances through which almost no current flow are called insulators. For example glass, wood, plastic, fur, silk etc.

State Joule's Law.

The amount of heat generated in a resistance due to flow of charges is equal to the product of square of current I, resistance R and the time duration t.

$$W = I^2Rt$$

Define electric power.

The amount of energy supplied by current in unit time is known as electric power.

$$\text{Power} = \frac{\text{Work}}{\text{Time}} = P = \frac{QV}{t} = IV = I^2R$$

Define kilowatt hour?

The amount of energy delivered by a power of one kilowatt in one hour is called kilowatt - hour. Mathematically:

One kilowatt - hour 1 kwh = 1000 w x 1 hour

Differentiate between A.C and D.C.

Alternating Current (A.C.):

The current which changes its direction again and again is called alternating current.

AC current can transfer electrical energy over the long distance.

The frequency of AC is 50Hz.

Direct Current (D.C.):

A current which always flows only in one direction is called direct current.

The DC cannot travel very far until it begins to lose energy.

The frequency of DC is zero.

What are live and neutral wires?

Neutral wire:

- One wire is earthed at the power station, so it is at zero potential.
- This wire is called neutral wire.
- This wire provides the return path of current.
- It is a black or blue in colour.

Live wire:

- The other wire on power station is at some certain potential called the live wire.
- The potential difference between both wires is 220.
- It is red or brown in colour.

How electricity Is dangerous for us?

- Our body is a good conductor of electricity through which current can easily pass.
- Therefore if a person holds live wire, then because of the presence of voltage in it, current will start flowing to ground through the human body which may prove fatal for the person.

What is a cable?

An insulated covered wire is known as cable.

Define fuse and write down its principle.

A small wire connected in series with the live wire is known as fuse wire or fuse.

Principle:

A specified amount of current can safely pass through it. When the current following through it exceeds this limit, it gets so hot that it melts.

What is Circuit Breaker? Also write down its principle.

It is a safety device which is used in place of fuse. Due to any fault when the current exceeds the safety limit, then the button of the circuit breaker moves upward. Due to which the circuit breaks and the flow of the current is stopped in it.

Principle:

It works on the principal of electromagnet. As soon as the current exceeds the limit, the magnetic force of the electromagnet is so increased that it attracts the iron strip towards it. Hence the contact points are separated and the circuit breaks.

How earth wire is useful to us? Principal of earth wire.

Whenever the metal casing of the appliance, due to faulty insulation, gets connected with the live wire, the circuit shorts and a large current would immediately flow to ground through the earth wire and causes the fuse wire to melt or the circuit breaker breaks the circuit. Therefore, the person who is using the appliance is saved.

What is mean by electromotive force? Write its equation and explain its unit.

The electromotive force of a battery or cell is the total energy supplied in driving one coulomb charge round a complete circuit in which cell is connected.

In other words, it is the energy supplied by a battery to a unit charge when it flows through the closed circuit.

Equation:

$$\text{e.m.f.} = \frac{\text{Energy}}{\text{Charge}} = E = \frac{W}{Q}$$

Unit of e.m.f.

SI units of energy and charge are Joule and coulomb, then the unit of emf will be JC^{-1}

Explain the V-I characteristics of Ohmic and non Ohmic conductor.

Ohmic Conductor:

Ohmic conductors have a linear current-voltage relationship over a wide range of applied voltages.

The straight line shows a constant ratio between voltage and current, So Ohm's law is obeyed.

For example most metals show Ohmic behavior.

Non-Ohmic Conductor:

Non Non-Ohmic materials have a non-linear current-voltage relationship.

For example, Filament lamp, Thermister, Filament lamp

Define and explain the term specific resistance. Discuss different factors which affect the resistance of conductors

The resistance of one meter cube of a substance is called its specific resistance.

Explanation:

A short pipe offers less resistance to water flow than a long pipe. A pipe with larger cross-sectional area offers less resistance than the pipe having smaller cross-sectional area.

Same is the case for resistance of wire that carry current the resistance of wire depends both on the cross-sectonal area and length of the wire, current flow also depends upon the nature of the material of the wire.

Factors:

a) Length of Conductor = Longer wires have more resistance.
b) Cross-Sectional Area = Thick wires have less resistance.
c) Nature of Conductor = Copper wire has less resistance than steel wire.
d) Temperature

Mathematically:

$R \propto L$

$R \propto 1/A$

$R \propto L/A$

$R = \rho L/A$

Where (ρ) is the constant of proportionality and known as specific resistnace.

How are resistances connected in series? What are characteristics of this combination?

i) In this method only one path is present for flow of current because resistances are connected end to end.
ii) The magnitude of current through each resistor is same.
iii) The sum of voltages across each resistor is equal to the voltage of battery.

$$V = V_1 + V_2 + V_3$$

If current is passing through resistors R_1, R_2, R_3 then

$$V = IR_1 + IR_2 + IR_3$$
$$V = I(R_1 + R_2 + R_3)$$

iv) The equivalent resistance R_e of a series combination is that resistance which when substituted in place of the combination the same current would flow through the circuit.

$R = R_1 + R_2 + R_3 + \ldots\ldots R_n$

How are resistances are connected in parallel. What are the characteristics of this combination?

i) In this combination potential drop across all the resistances is the same.
ii) The sum of current flowing through the various resistances is equal to the total current.

$$I = I_1 + I_2 + I_3$$

iii) The equivalent resistance Re of the parallel combination is that resistance which when substituted in place of the parallel combination does not alter the total current of the circuit.

$1/R_e = 1/R_1 + 1/R_2 + 1/R_3$

$1/R_e = 1/R_1 + 1/R_2 + 1/R_3 \ldots\ldots\ldots\ldots 1/R_n$ (For n resistances)

Describe the Electric Energy and Joule's Law?

i) We know that during flow of current positive charges always flows towards negative. Thus electric current becomes a continuous source of energy.
ii) Consider two points having a potential difference of V volts. If one coulomb of charge passes between these point, the amount of energy supplied by the charge would be V Joule. Hence when Q coulomb of charge flows between these two points then we will get QV joule energy. We can represent it as:

$W = QV$.

iii) As current is rate of flow of charge so the energy gained during t second is: -

$W = QV = I \times t \times V$ ....(i)

By ohm's law

$V = IR$

$W = I^2Rt$ Substituting the value of V in Equ (i)

iv) This energy can be utilized for different functions e.g. fan convert this energy into mechanical energy.

Define Cycle.

The set of all the value of current during one period is known as one cycle. The number of cycles completed by alternating current in one second is called its frequency.

How Circuit become short?

A short circuit occurs when circuit with a very low resistance is formed. The low resistance causes the current to be very large.

How insulation damage?

- Electrical current exceeds the rated current carrying capacity of the conductor it can produce excess current that can damage insulation due to overheating of cables.
- Constant friction may also remove the insulation from the wire.
- Too much moisture also damages the insulation because moisture decrease resistance and increase the rote of current.

The voltage chosen for the transmission of electrical power over large distances is many times greater than the voltage of the domestic supply. State two reasons why electrical power is transmitted at high voltage.

i) Sending power at high voltage would reduce the power loss in the form of heat dissipation i.e. I^2Rt. For same power, high voltage means lower current and hence less power loss.

ii) Sending power at high voltage means low current. It means we need thinner wires and also less number of repeater step-up transformers to send power over long destinations.

Why is the voltage used for the domestic supply much lower than the voltage at which the power is transmitted?

Domestic appliances operate on low voltage because high voltage can damage these instruments. High voltage can also be dangerous for users as it can cause electric shock. It may also damage property and other valuables as a result of some serious electric shock.

Which metal is used as the filament of an electric bulb?

Tungsten is used as the filament due to high resistance.

A bird can sit harmlessly on high tension wire. But it must not reach and grab neighboring wire. Do you know why?

A bird can sit harmlessly on high tension wire as no current passes through its body, since the potential of the wire is constant. However, if the bird grabs the neighbouring wire, then due to potential difference of two wires, current will flow through the body of the bird and can be fatal

In order to measure voltage in a circuit, voltmeter is always connected in parallel. Discuss.

In this way, voltmeter does not disturb the current and hence the voltage of the circuit. Due to high resistance of voltmeter, no current passes through it and hence voltage of the circuit remains unaffected.

In order to measure current In a circuit, why ammeter Is always connected in series?

In order to measure current ammeter is always connected in series with the circuit so that all the current to be measured must flow through it (due to its low resistance).

What is difference between cell and battery?

- Cell is the specific name of source of emf in which chemical energy is converted into electrical energy.
- Battery is more general name of source of emf in which any kind of energy (heat, solar, chemical, mechanical) energy is converted into electrical energy.

From your experience in watching cars on the roads at night, are automobile headlamps connected in series or in parallel?

Head lamps of automobiles are connected in parallel because of the following reasons:

- The potential difference between headlamps remains same.
- If one head-lamp is out of order the other lamps still glow. Also we can turn ON or
- OFF any individual head lamp independently, which is only possible if they are connected in parallel.

It Is Impracticable to connect an electric bulb and an electric heater in series. Why?

- When appliances are connected in series, total resistance of circuit increases. This decreases the current and hence the power through each appliance.
- In order to avoid this loss of current and power, through bulb and heater, they are connected in parallel.

Does a fuse in a circuit control, the potential difference or the current?

- Fuse in a circuit is used to control the current in the circuit.
- When current exceeds the limited value as allowed by the fuse, it burns out, stops the current and beaks the circuit.

NUMERICAL PROBLEMS

14.1 *A current of 3mA is flowing through a wire for 1 minute. What is the [illegible] flowing through the wire?*

Solution: ***Given Data:***

Current I = 3 mA = 3.0×10^{-3} A

Time t = 1 min. = 60 sec.

Q = ?

Formula: I = V.........By definition

Q = I t

Putting values, we get Q = $3.0 \times 10^{-3} \times 60$

Q = 180×10^{-3}

Q = 180 m C

14.2 *At 100,000 Ω, how much current flows through your body if you touch the terminals of a 12 V battery? If your skin is wet, so that your [illegible] is only 1000 Ω, how much current would you receive from the same [illegible]?*

Solution: ***Given Data:***

Resistance R = 100,000 Ω =1 M Ω

Current I =? If Battery is V =12 Volts

Find Current I = ? For same battery but R = 100 Ω

Ohm's law V =I R.........By definition

$I = \frac{V}{R}$

Putting values, we get $I = \frac{12}{100000}$

I = 1.2×10^{-4} A

[illegible] Ohm's law V =I R.........By definition

$I = \frac{V}{R}$

Putting values, we get $I = \frac{12}{1000}$

I = 1.2×10^{-2} A

14.3 *The r[illegible]ance of a conductor wire is 10 MΩ. If a potential difference of [illegible] applied across its ends, then find the value of current passing thr[illegible] in mA*

Solution: ***Given Data:***

Resistance R = 10 M Ω =1.0×10^{7} Ω . $1M = 10^{6}$

Current I =? If Battery is V =1 0 Volts

By Ohm's law V =I ....By definition

$$I = \frac{V}{R}$$

Putting values, we get $I = \frac{100}{10000000}$

$I = 1.0 \times 10^{-5} A$

$I = 0.01\ mA$

14.4 By applying a potential difference of 10 V across a ... of 1.5A passes through it. How much energy would ... current in 2 minutes?

Solution: ***Given Data:***

Potential diff. $V = 10$ Volts

Current $I = 1.5$ A

Energy = ?

If current passes for time t = 2 min = 120 sec .

. 1 min. = 60 sec.

First we find resistance R = ?

By Ohm's law $V = IR$ ...... By definition

$$R = \frac{V}{I}$$

Putting values, we get $R = \frac{10}{1.5}$

$R = 6.7\ \Omega$

By Definition: $W = I^2 R t$

Putting values, we get $W = (1.5)^2 \times 6.7 \times 120$

$W = 1809$ joules

14.5 Two resistances of 2kΩ and 8kΩ are joined in series ... connected across the ends of this combination, find ... quantities:

(a) Equivalent resistance of the series combination.

(b) Current passing through each of the resistan...

(c) The potential difference across each resistance

Solution: ***Given Data:***

Resistances $R_1 = 2K\Omega$ and $R_2 = 8\ K\Omega$

Voltage $V = 10$ volts

(a) Equivalent resistance R_e = ?

(b) Current through each resistor I = ?

(c) Potential across each resistor V_1 = ? And V_2 = ?

(a) As the resistors are connected in series, so we know Formula:

$Re = R_1 + R_2$

$Re = 2\ k\Omega + 8\ k\Omega$

$Re = 10\ k\Omega$

(b) For series, current will be same through all resistors. By ohm's law

$$V = IR = \quad I \quad \frac{V}{R_e}$$

Putting values we get: $I \quad \frac{10}{10000}$

$I \quad 1.0 \times 10^{-3} A = 1\ mA$

The potential differences across R_1 is $V_1 = IR_1$

$V_1 = (10^{-3}) \times (2\times10^3\Omega)$

$V_1 = 2$ Volts

Similarly the potential difference across R_2 is $V_2 = IR_2$

$V_2 = (10^{-3}) \times (8\times10^3\Omega)$

$V_2 = 8$ Volts

... resistance of 6kΩ and 12kΩ are connected in parallel. A 6V battery is ...nected across its ends, find the values of the following quantities:

Equivalent resistance of the parallel combination.

Current passing through each of the resistances.

Potential difference across each of the resistance.

Solution **Given Data:** Figure 14.10 page No.107

The resistances are $R_1 = 6\ K\Omega$, $R_2 = 12\ K\Omega$ With two resistances

Potential $V = 6$volts

(a) $R_e = ?$ (b) $I_1 = ?, I_2 = ?,$ $I_3 = ?$ $I = ?$

As the resistances are in parallel combination:, we use formula

$$\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2}$$

Putting valu...

$$\frac{1}{R_e} = \frac{1}{6\times10^3} + \frac{1}{12\times10^3}$$

$$\frac{1}{R_e} = \frac{2+1}{12\times10^3} =$$

$$= \quad R_e = \frac{12\times10^3}{3} = 4\ K\Omega$$

...current can be found $V = I R_e$ $=$ $I = \frac{V}{R_e}$

$$I = \frac{6}{4\times10^3} = 1.5\times10^{-3} A$$

$$I = 1.5\ mA$$

...ent through R_1 is $I_1 = \frac{V}{R_1} = \frac{6}{6\times10^3} = 1\ mA$

...ent through R_2 is $I_2 = \frac{V}{R_2} = \frac{6}{12\times10^3} = 0.5\ mA$

(c) As the resistances are in parallel combination so all the resistances are at the same potential $V = 6$ Volts.

14.7 An electric bulb is marked with 220V, 100W. Find the resistance of the filament of the bulb. If the bulb is used 5 hours daily, find the energy in kilowatt-hour consumed by the bulb in one month (30 days).

Solution: ***Given Data:***

Potential diff. $V = 220$ Volts

Power $P = 100$ Watts

Resistance $R = ?$

It is is used daily for time $t = 5$ hours

Energy $= ?$ (kwh) We know $1\text{ kwh} = 3.6 \times 10^6$ Joules

First we find current $I = ?$

By Power formula: $P = IV = \frac{V^2}{R} = R = \frac{V^2}{P}$

Putting values, we get $R = \frac{(220)^2}{100}$

$R = 484\ \Omega$

By Definition: $W = Pt$

$3.6\times10^6\ joules = 1kwh$

Putting values, we get $W = 100\times5\times30\times3600$

$W = 15\times3600{,}000$ joules

$W = 15$ kwh

14.8 An incandescent light bulb with an operating resistance of 95 Ω is labeled "150 W." Is this bulb designed for use in a 120V circuit or a 220V circuit?

Solution: ***Given Data:***

Resistance $R = 95\ \Omega$

Power $P = 150$ Watts

Is is designed for 120 Volts or 220 Volts = ?

By Power formula: $P = \frac{V^2}{R}$ $= V^2 = PR$

Putting values, we get $V^2 = 150\times95$

$V^2 = 14250$

Taking under root $V = 120$ Volts

It is designed for 120 Volts.

.4 ... is installed with

... bulbs of 60W each of which are used 5 hours daily.

fans of 75 W each of which run 10 hours daily.

One T.V. of 250 W which is used for 2 hours daily.

... electric iron of 1000W which is used for 2 hours daily.

... unit of electricity is Rs 4. Find the monthly expenditure ... 30 days

So *Given Data:*

Appliances of different power are given.

Let we find the total energy consumed by the appliances.

$E_a = 10\times60\times5 = 3000$ Wh

$E_b = 4\times75\times10 = 3000$ Wh

$3.6\times10^6\ joules = 1kwh$

$1KW = 1000W$

$E_c = 250\times2 = 500$ Wh

$E_d = 1000\times2 = 2000$ Wh

$E_T = E_a + E_b + E_c + E_d = E_T = 3000 + 3000 + 500 + 2000$

$E_T = 8500$ Wh

Total energy consumed for 30 days $E_T = 8500\times30 = 255000$ Wh

$E_T = 255$ KWh

We know 1 KWh is termed as 1 unit of electricity commercially.

Total cost = 255 Units × 4 (Rupees)

Total cost = 1020 (Rupees)

... a 4 kW water heater are connected to a 250 V ... the current which flows in each appliance (b) the ... appliance when in use.

...

Power of lamp $P_1 = 100$ W

Power of heater $P_2 = 4$ kW = 4000 Watts

Voltage $V = 250$ V

(a) Current in lamp $I_1 = ?$ & Current in heater $I_2 = ?$

Formula for power: $P = I\,V$

Current through lamp $I_1 = \frac{P_1}{V}$

Putting values, we get $I_1 = \frac{100}{250}$

$I_1 = 0.4$ A

Current through heater $I_2 = \frac{P_2}{V}$

Putting values, we get $I_2 = \frac{4000}{250}$

$I_2 = 8\ A$

For resistance we use formula $V = IR$

Resistance through lamp $R = \frac{V}{I_1}$

Putting values, we get $R = \frac{250}{0.4}$

$R = 625\ \Omega$

Resistance through heater $R = \frac{V}{I_2}$

Putting values, we get $R = \frac{250}{8}$

$R = 31.25\ \Omega$

14.11 A resistor of resistance 5.6 Ω is connected across a battery of 3.0V by means of wire of negligible resistance. A current of 0.5 A passes through the resistor. Calculate

(a) power dissipated in the resistor

(b) total power produced by the battery

(c) Give the reason of difference between these two quantities

Solution: Given Data:

Resistance $R = 5.6\ \Omega$

Potential difference $V = 3.0$ Volts

Current $I = 0.5\ A$

(a) Power dissipated $P = ?$

(b) Total power produced by battery $P = ?$

(c) Reason

(d) Current in lamp $I_1 = ?$ & Current in heater $I_2 = ?$

Formula for power: $P = I^2R$ (It is power dissipated in resistor)

Putting values, we get $P = (0.5)^2 \times 5.6$

$P = 1.4$ Watt.........(1)

$P = IV$ (It is power delivered by the battery)

Putting values, $P = (0.5)\times 3.0$

$P = 1.5$ Watt.........(2)

From equation (1) and (2) The difference is $= 1.5 - 1.4 = 0.1$ Watt

This power is lost by the internal resistance of the battery.

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THEORY

Question: Draw the lines of force in case of straight current carrying conductor?
When electric current flows in straight conductor, then shape of lines of magnetic field is of concentric circles.

Question: Describe the magnetic field of a current carrying solenoid?
i) A solenoid is a closely wound cylindrical coil of insulated wire.
*****Draw fig here from book here.**
ii) These lines emerge out from one end of solenoid and after encircling around it, enter into it through other end.
iii) Inside the solenoid the lines of force are parallel and all point in the same direction.
iv) The pattern of these lines resemble with the lines of magnet.
v) Due to this resemblance we can say that one end of solenoid behaves like North Pole and other like South Pole.
vi) The **polarity** of a current carrying solenoid can be determined by the following rules.
a) "Hold the solenoid in your right hand by curling the fingers in the direction of the current, the stretched thumb would indicate towards the North Pole."
b) Hold down the end of the current carrying solenoid in front of you, if the direction of current flow through this end is anticlockwise, it would be North Pole, otherwise it would be a south pole."

Question: How direction of lines of force can be determined?
The direction of lines of force can be determined by the right hand rule. If we grasp the current carrying conductor in our right hand with the thumb being stretched in the direction of current, the fingers would curl in the direction of lines of force.

Question: Describe the nature of force on a current carrying conductor in a magnetic field?
When a current carrying conductor is placed in magnetic field, it experiences a force, which is described in experiment below: -
Experiment: -
i) Take a large size cork and fix two iron nails into opposite faces.
ii) Nails should not touch each other in cork.
iii) Clamp the cork on a stand so that the nails are horizontal.
iv) Now take thick wire and bend it in U shape and make hooks at its tow ends.
v) Now suspend U shaped wire such that it passed from horseshoe magnet.
*****Draw Fig here from book.**
vi) Connect the two nails with battery and switch.
vii) Press the switch key. Now current will start flowing in wire and wire will moves inwards.

viii) This movement of wire is cue to the force, which is acting on the side AB of the wire.
ix) The direction of force acting on side AB of the wire can be found by Fleming's left hand rule.

Fleming's left hand rule: -

"According to this rule, stretch the thumb, forefinger and the middle finger of the left hand mutually at right angles to each other. If the forefinger points in the direction of magnetic field, the middle finger in the direction of the current, then the thumb would ind cate the direction of the force acting on the conductor."

x) Experiments shows that force acting upon the conductor in such a case is directly proportional to sin 0.
xi) So, if the conductor is placed parallel to the field, no force would act upon the conductor because the value of sin0 is zero in this case.

Question: Write a detailed note on D.C Motor?

Structure: -

i) It consists of rectangular coil abcd mounted on a spindle so that it can rotate between the poles of a permanent magnet.
ii) A copper ring is fixed on the spindle of the coil. This ring split into two halves S_1 and S_2.
iii) Two carbon brushes X and Y are caused to press lightly against the rings.
iv) When these brushes are connected to a battery, the coil starts rotating.

*****Draw fig from book here.**

Function: -

i) Let the coil is in horizontal position when the current is passed.
ii) Ring S_1 is in contact with brush X and S_2 with Y.
iii) According to Fleming's left hand rule, the force acting on side ab is directed upward and onside cd is directed downwards.
iv) Under the action of these two forces, a couple acts on coil, which causes it to rotate clockwise.
v) When coil reaches the vertical position, the brushes reach to the vacant space between the split rings and their connection with the coil is cut off and no current would flow.
vi) But coil continue to move beyond vertical position due to momentum.
vii) Connection of split rings with brushes is again established.
viii) But this time brush X is in contact with the ring S_2.
ix) Now the direction of flow of current is reversed but coil continue its rotation clockwise.
x) In this way D.C Motor converts the electrical energy into mechanical energy, which is utilized for different types of work.

Question: Explain the term Electromagnetic Induction?

We know that the lines of force are in the form of concentric circles. In the case of bar magnet lines start from North Pole and end at South Pole. Then they pass from South Pole to North Pole through the magnet, thus making a closed loop. The number of

magnetic lines of force passing through any surface is known as **magnetic flux** through that surface.
If magnetic flux through a coil or a solenoid is changing, an emf is induced in it. This can be explained by an experiment.

Experiment: -

i) Take a solenoid and connect a galvanometer with its two ends.
ii) If North Pole quickly moved towards the end A of solenoid, the needle of galvanometer gets deflected, which shows that an emf has been generated in the solenoid.
iii) Now stop the motion of magnet, we shall see that deflection in the galvanometer gets zero.
iv) This means that induced current flows only when magnet is moving.
v) The amount of deflection in galvanometer depends upon the speed of magnet.
vi) If North Pole moved away from end A, again galvanometer shows deflection but this time opposite in direction.
vii) Similar results will be obtained if magnet is kept stationary and solenoid is moved towards or away from magnet.

From this experiment we conclude that an emf is induced in the coil when there is relative motion between coil and magnet. This phenomenon is called **electromagnetic induction**.
According to Faraday: -

"The value of the induced emf is directly proportional to the rate of change of flux. This is knows as Faraday's Law of Electromagnetic induction."

Question: Write a detailed note on A.C Generator?
A generator, which produces or generates alternating e.m.f. is called A.C Generator.

Construction: -

i) It consists of a rectangular coil, which is rotated between poles of a permanent magnet.
ii) The ends of wire of coil are soldered with two circular slip rings. These rings are fixed on arm of the coil.
iii) Two carbon brushes are kept in contact with these slip rings.
iv) At outside surface of slip rings connections are taken out to draw electric current from the coil.

Function: -

i) The induced emf is generated when coil is rotated by applying mechanical energy.
ii) Suppose, at the start, coil is vertical with its side A upward.
iii) In this position side A and B are moving along the direction of lines of magnetic field. Therefore rate of change of magnetic flux is zero. Hence induced emf is also zero.
iv) After one quarter rotation, side A and B are moving at right angle to the direction of magnetic lines of force, so rate of change of magnetic flux is maximum and maximum emf is obtained.

v) After half quarter rotation, again side A and B move parallel to lines of magnetic field, so magnetic flux change and emf will be again zero.
vi) After three quarter rotation, side A and B are moving at right angle to the direction of magnetic lines of force, so rate of change of magnetic flux is again maximum and again maximum emf is obtained.
vii) Similar graph is completed for every next complete rotation of coil.

Question: Write a note on mutual induction?
***Draw fig from book.
i) In fig two coils X and Y are shown placed close to each other.
ii) Coil X is connected to battery and coil Y is connected to galvanometer.
iii) When switch is closed galvanometer shows deflection showing that current is flowing.
iv) Similarly when switch is open, galvanometer shows opposite deflection.
v) We can explain these observations on the basis of magnetic flux passing through passing through two coils.
vi) So we can say that If a current is induced in a circuit due to a change of current in another circuit, this phenomenon is known as **mutual induction**.

Question: Write a note on Self Induction?
i) We know that when current passes through a coil, it produces magnetic field.
ii) If the current passing through the coil changes, then the magnetic field produced by it also changes, which results in a change in the number of lines of force passing through the coil.
iii) In other words, the magnetic flux linked with the coil changes.
iv) This causes an induced emf in the coil which is known as self induced emf and this phenomenon is called **self induction**.

Question: Write a note on transformer?
This is an electrical device, which is used to increase or decrease the value of alternating voltage.

Structure: -
i) It consists of two coils, which are wound on two different sides of a rectangular iron core.
ii) One coil is called primary other is called secondary.

Function: -
i) The alternating voltage, whose value is to be altered, is supplied to the primary due to which an alternating current begins to flow through it.
ii) This current creates a continuously changing magnetic flux through the primary coil.
iii) The iron core enhances the magnetic flux to a very large value.
iv) As the flux is continuously changing, therefore, in accordance with the principal of mutual induction, an alternating voltage is induced across the secondary coil.
v) The value of this voltage depends upon the number of turns in the primary and secondary coils.
vi) If

a. N_p = No. of turns in the primary coil.
b. N_s = No. of turns in the secondary coil.
c. E_p = Voltage applied across primary coil.
d. E_s = The required voltage generated

Then

$E_s / E_p = N_s / N_p$

vii) According to this formula, if the voltage applied across primary coil is to be decreased, i.e. $E_s < D_p$, then Ns would also be smaller as compared to N_p. Such a transfer is called **step down transfer**.

viii) On the other hand if voltage applied to the primary coil is to be increased, the number of turns in the secondary would be large as compared to number of turns in the primary. Such a transfer is known as a **step up transformer**.

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THEORY & SOLVED EXERCISE

Describe using one simple diagram in each case, what happens when a narrow beam of electrons is passed through (a) a uniform electric field (b) a uniform magnetic field. What do these results indicate about the charge on the electron?

Uniform Electric Field:

When an electron beam is passed through a uniform electric field it deflects and accelerates the electron beam.	

Uniform Magnetic Field:

When an electron beam is passed through a uniform magnetic field it only deflects the electron beam	

The two above results show that electrons carry negative charge.

Explain the working of different parts of oscilloscope.

Cathode Ray Oscilloscope (CRO):

It is used to display the magnitude of rapidly changing electric current or potentials as a function of time. The information is displayed on the face end of cathode ray tube called fluorescent screen. It consists of following components:

The Electron Gun:

- It is essential and initial part of cathode ray tube and consists of electron source which is electrically heated cathode that ejects electrons.
- It has an electrode called grid G for controlling the flow of electrons in the beam. The grid G is at negative potential with respect to cathode.
- By making it more negative with respect to cathode, so electrons are repelled and fewer electrons reaching the screen.
- It controls the number of electrons so intensity of the beam and hence, the brightness of the luminous spot at the screen.
- The two anodes A1 and A2 which are at high positive potential with respect to cathode F accelerate as well as focus the electron beam to fixed spot on the screen.

The Deflecting Plates:

- After leaving the electron gun, the electron beam passes between two pair of plates.
- A pair of horizontal plates. A potential difference applied between these plates deflects the beam in a vertical plane. This pair of plates provides the Y-axis or vertical movement of the spot on the screen.
- Similarly, second pair of vertical plates provides the X-axis or horizontal movement of the spot on the screen.

A fluorescent screen:
- The screen of a cathode ray tube Consists of a thin layer of a phosphor, which is a material that gives light as the result of bombardment by fast moving electrons.
- The phosphor is applied to the inside of the end of the tube by spraying, dusting or precipitation from a liquid.

Write some uses of oscilloscope.
Cathode ray oscilloscope is a versatile electrical instrument which is in fact a high speed graph plotting device.
Voltage Measurement:
Enter the unknown voltage at "Y-input" and the "VOLT/DIV" knob at the oscilloscope can be tuned to be used as voltmeter.
Time Measurement:
By adjusting the "TIME/DIV" knob the oscilloscope can be used to measure the time.
To show the x-t signal:
Oscilloscope can display the time signal (voltage-time or current-time) I output whether it can be shown in beat high frequency wave.
To show the x-y graph:
The relation between two variables can be displayed by entering a horizontal signal and vertical signal.

Considering an oscilloscope explain the followings.
How the filament is heated?
Filament is heated by a battery usually of 6 Volts.
Why the filament is heated?
Filament is heated to get the electrons by thermionic emission.
Why the anode potential is positive with respect to the cathode potential?
The anode potential is positive with respect to the cathode because I electrons being negatively charged particles are accelerated towards the anode (positive potential).
Why large potential is applied between anode and cathode.
The degree of deflection and acceleration produced in electrons is proportional to the strength of the electric field, so high potential will accelerate the electrons to high speed and they shoot straight through the hole of the anode in a fine beam of electrons.
Why the tube is evacuated?
The tube is evacuated because electrons could not collide with other gas to give rise other electrons and ions.

What is electron gun? Describe the process of thermionic emission.
- Electron gun is an important mean to provide continuous beam of electrons.
- It consists of a evacuated glass tube at a very low pressure.
- The electrons are produced by thermionic emission from a tungsten filament heated by a battery, usually 6 V supply.
- A high positive potential (several thousands) is applied to cylindrical anode (+).
- The electrons will be accelerated to a high speed and they shoot straight through the hole of the anode in a fine beam of electrons.

What do you understand by digital and analogue quantities?

Analogue Quantities:

The analogue quantities are those whose values vary continuously. For example the variation of temperature with time during a day. This shows that temperature variation with time is continuous. So we can say that temperature is an analogue quantity with respect to time. Similarly, pressure, distance covered by a moving car etc are all analogue physical quantities.

Digital Quantities:

The part of electronics which processes the data provided in the form of digits or numbers is known as "digital electronics". Digital electronics uses only two numbers 1 (high) and 0 (low), the whole data is provided in binary system due to which processing has become very easy.

Differentiate between analogue electronics and digital electronics. Write down names of five analogue and five digital devices that are commonly used in everyday life.

Analogue Electronics:

The section of electronics, which is concerned with circuits processing analogue quantities like current, voltage etc, is called analogue electronics. Five analogue devices are:

1) Refrigerators 2) Electric fans 3) Electric iron
4) Electric lamps 5) Radio receiver.

Digital Electronics:

Digital electronics use the digital signal in a sequence of voltage pulses represented in binary digits "0" and "1". Computer operates by counting the digits. Fives digital devices are:

1) Computer 2) T.V. 3) Digital camera
4) Mobile Phone 5) Security system

State and the explain each case whether the information given by the following devices is in analogue or a digital form.

a) a moving-coil voltmeter measuring the e.m.f of a cell.

It is analogue device which measure the value of emf of a cell. The deflection of the moving coil is continuous variation with time. It is analogue signal.

b) a microphone generating art-electric current.

A public address system (loud speaker system) is an example of analogue electronic system. The microphone converts sound energy into continuously varying voltage/current. It is called analogue voltage/current signal. This signal is applied to an amplifier, which is also analogue electronic circuit, which amplifies the signal without changing its shape, which operates the loud speaker.

c) a central heating thermostat controlling the flow of traffic.

The thermostat depends upon the atmospheric temperature which varies continuously with time. It is an analogue signal. So the thermostat controlling the flow of traffic is an analogue device.

d) automatic traffic lights controlling the flow of traffic.

It is a digital system which is being operated between two values "1" high (Present) and low "0" (Not present).

Write down some benefits of using digital electrons over analogue electronics.

Digital electronics use the digital signal in a sequence of voltage pulses represented in binary digits "0" and "1". Computer operates by counting the digits. The process with numbers becomes fast, reliable and less error as unpaired to analogue signal.

Digital electronics is being used in every modern electronic device like modern telephone system, radar system, naval and other military controlling systems, modern cameras, control system of operation of industrial machines, medical equipment etc.

What are the three universal Logic gates? Give their symbols and truth tables.

Logic Gates:

The electronic circuit which are designed to implement various logic operations. These circuits are called logic gates.

AND Gate:

- The electronic circuit which implement AND operation is called AND gate.
- In digital electronics 0 and 1 digits are allotted to two potential levels 0 for minimum or low, and 1 for maximum or high.
- Usually 0 is used for earth and 1 is used for 5V (typical value).
- The truth table and symbol for AND gate is shown in figure below.

A	B	X
0	0	0
1	0	0
0	1	0
1	1	1

OR Gate:

- The electronic circuit which implement the truth table of OR operation in called OR gate.
- The truth table and symbol for such a circuit is shown in figure.
- The gate also has two (or more than two) inputs and has only one output OR operation is represented as follows X= A+B.
- It is read as "output X is equal to input A or input B". The truth table for OR operation is given below:

A	B	X
0	0	0
1	0	1
0	1	1
1	1	1

NOR Gate:

- In this type of operation there is only one Boolean variable as input.
- And has one Boolean variable as output.
- Not operation always negates the sense of input for example if we have logic statement that.
- X is student of 1oth class then its negative is the output, which is "X is not student of 10th class".
- This shows that if input is, 1 then output is, O. and if input is zero the output is equal to 1.
- This operation is symbolically written as.

Output = negation of single input A, It is written as

$$x = \bar{A}$$

- It is read as a output is equal to negation of input A. It is also read as "X equals A NOT".
- The truth table for the NOT operation is shown in figure below.

A	**$X = \bar{A}$**
1	0
0	1

Name two factors which can enhance thermionic emission.

It cepends upon:

i) The substance used as filament because different materials have different number of free available electrons.

ii) The value of the battery used to make it heated.

Give three reasons to support the evidence that cathode rays are negatively charged electrons.

- The cathode rays are deflected and accelerated towards positively charged plate.
- The deflection of cathode rays is the presence of magnetic field shows that these are negatively charged particles.
- Grid in the oscilloscope is negatively charged and the electrons are repelled by the grid G. It shows that cathode rays (electron beam) is negatively charged particles.

When electrons pass through two parallel plates having opposite charges they are deflected towards the positively charged plate. What important characteristics of the electron can be inferred from this?

If electrons will deflect towards the positive charged plate it means electrons are negatively charged particles.

When a moving electron enters the magnetic field, it is deflected from its straight path. Name two factors which can enhance electron deflection.

- Fast moving electrons pass through magnetic field, they are deflected from their straight path shows that these are charged particles.
- The deflection can be enhanced by increasing the velocity and magnetic field strength.

In what ways is an oscilloscope a voltmeter?

Voltage Measurement:

Enter the unknown voltage at "Y-input" and the "VOLT/DIV" knob at the oscilloscope can be tuned to be used as voltmeter.

How can you compare the logic operation X = AB with usual Operation of multiplication.

There is logic operation which is give by the equation (X = A.B). It is called AND gate. The truth table of this gate is given below.
This particular gate holds the usual operation of multiplication.

A	B	X
0	0	0
1	0	0
0	1	0
1	1	1

NAND gate is the reciprocal of AND gate. Discuss

NAND gate is not reciprocal of AND gate. We can say that NAND gate is inversion of AND gate. If X is output of NAND gate then mathematically we can write as X = A.B

REVIEW QUESTIONS

What is difference between data and information?

Data is raw information in the form of figures, alphabet, or graphics. But information is a processed data on some logical operations that can be used for useful purposes.

What do you understand by information and communication technology (ICT)?

Information and communication technology is electronic based system which deals with scientific methods and means to store and process vast amount of information in seconds and of telecommunication to transmit it almost instantaneously.

It is combination of two fields, namely "Information Technology" (IT) and "Communication Technology" (CT).

What are the components of information technology? Clearly indicate the function of each component.

There are five parts (components) work together to produce Computer Based Information System (CBIS).

1) Hardware:

The term hardware refers to machinery. This includes the computer itself, which is referred as central processing unit (CPU), and all of its supporting devices like input, output, storage and communication devices.

2) Software:

The term software refers to computer programs. Computer programs are machine-readable instructions that direct the circuitry within the hardware parts of the CBIS to function in ways that produce useful information from data. Programs are usually stored on disks.

3) Data:

Data are facts that are used by programs to produce useful information. It may in the form of graphic or figure that can be recorded. Data is usually stored on disk or tape.

4) Procedure:

These ate set of instructions and rules to design and use information system. These ate written in manuals and documents for use.

5) People:

Every CBIS needs people if it is to be useful. The component "people" that most influence the success or failure of information systems.

Differentiate between the primary memory and the secondary memory.

Primary Memory:

It is based on electronics and consists of integrated circuits (ICs). It is Random Access Memory (RAM). It vanishes when the computer is switched off.

Secondary Storage Devices:

The data stored devices are generally the secondary memory of the computer. It is used to store data permanently in the computer. When we open a program data is moved from the secondary storage into the primary storage

Name different information storage devices and describe their uses.

Audio And Video Cassettes:

Audio (related to sound) cassettes consist of magnetic tapes on which sound is saved in a particular form by the help of magnetic field. Microphone changes sound waves into electric pulses which are made by amplifier.

Magnetic Disks:

There are different types of magnetic disks, which are coated, with a layer of some magnetic material. The read/write head of disks is similar to the record replay head on a tape recorder.

Floppy Disk:

A floppy disc is made of flexible plastic wafer packed in plastic case. It is coated with magnetic oxide. Floppy disc is cheap, convenient, and reliable but lack the storage capacity and speed for many large jobs. It has storage capacity from 1 to 3 MB.

Hard Disk:

Hard disc is made of aluminum and is not flexible like floppy drive or CD's. It is enameled with a layer of a metal like Fe, Co, Kr, Ni which can be magnetized easily. Hard disk has higher speed and larger capacity of data storage. It is also called storage disk. A large amount of information can be read or write on the hard disk.
Hard disk is made by joining many plates and each is accessed via read/write head on a moveable armature. This disc revolves inside a box with great speed about its axis. It is enclosed in by a jacket to avoid exterior pollution.

Compact Disc (CD):

It is molded plastic disc containing digital data that is scanned by a laser beam for the reproduction of recorded sound or other information. A pit pattern is formed on it. This has billions of pits of varying lengths and spaces on a shiny disc. Shiny area between every two consecutive pits is called a "flat". The pit pattern is read by fine laser beam. It is focused on a particular take.

Flash Drive:

It is an electronic device that consists of data storage ICs. A flash drive is a small storage device that can be used to transport files from one computer to another. A flash drive is easy to use. Once we have created a paper or other work. We can simply plug our flash drive into a USB port and the work can be saved in the flash drive.

Explain briefly the transmission of radio waves through space?

Information like sound, video clips, graphics etc. can be sent from one place to another place. First by changing the information into electrical signals and then these signals are superimposed on electromagnetic waves which are called carriers waves. These carriers waves travel in space and then at the receiving end this information is demodulated into original information.

How light signals are sent through opticalfiber?

As "Optics" means related to "Light" & "Fiber" means "Thread". Optical Fiber is a strand of glass or plastic not much thicker than human hair uses light signals to transfer information from one end to other.

Principle:

Propagation of light signals in an optical fiber requires the light should be confined within the fiber. This is done by total internal reflection that the angle of incidence should be greater than the critical angle.

What is computer? What is the role of computer in everyday life?

Computer is an, electronic, computing device. It makes analysis, operations like addition, subtraction, multiplication etc and arranges the· information given to it.

Role of Computer:

Computer has changed the world revolutionary. It has made the world into a global village. Computer is one of the base components of information technology. Using computer we can collect and share the knowledge through Internet. Almost all the offices have computer to manage their day-by-day work.

What is the difference between hardware and software? Name different software.

Computers work through an interaction of hardware and software.

Hardware:

Hardware of a computer is a solid device like keyboard, mouse, monitor, motherboard etc.

Software:

Software refers to the instructions, or programs that tell the hardware what to do. For example operating systems, Microsoft application (MS Office) etc.

Operating System:

It is essential for a computer having operating system. For example: Windows, Linux, Unix are the operating systems.

What do understand by the term worn processing and data managing?

Word Processing:

It is a computer program, which helps us to write letters, reports and books. Hence, to type something by computers keyboard, to correct, to arrange, to amend the document, to add and delete the written portion when required is called the word processing.

Data Managing:

The information about a subject can be stored in the computer in more than one interlinked files, which may be shared in different programs. This is called "Data Managing" Addition and deletions in the data are possible.

What is internet? Internet is a useful source of knowledge any information. Discuss.

Internet is a worldwide network of computers that use common communication standard and interface to provide the physical backbone for a number of interesting applications.

- Today internet comprises of many million computers.
- The language used in Internet is called HTML, which is abbreviation of Hypertext Markup Language.
- All connected computers communicate through same code.

- It is called "protocol" whose name is TCP/IP. It is abbreviation of Transmission Control Protocol / Internet Protocol.
- Basically three major search services available for different tasks.
- Directories, search engine and Meta search engine.

Discuss the role of information technology in school education.

Information Technology (IT):

The scientific method for storing, arranging information for proper use and to communicate them to others is called the information technology (IT). Computers and internet, etc are the main sources for the information technology.

Role of IT in School Education:

School education is an important aspect of human life. If from the growing age the students are familiar with computers then it will be easy for them to get maximum benefits from computer technology.

Utilizing the computers we can meet and compare the international standard of school education. There should be computer labs in schools. Studerts and teachers should have access to internet. For students they should get permission from their teachers to use internet for useful purposes under the supervision of their teachers.

Why Optical Fiber is more useful tool for the communication in process.

Optical fiber is a strand of glass or plastic (not thick than human hair) uses light signal to carry the information. Light signals have very high frequency so more information can be send per second over large distances withcut interruption and loss of information.

Which is more reliable floppy disk or a hard disk.

Hard Disk is more reliable and safe.

What is difference between RAM and ROM?

Random Access Memory (RAM):

It is based on electronics and consists of integrated circuits (ICs). It is Random Access Memory (RAM). It vanishes when the computer is switched off.

Read Only Memory (ROM):

It is based on electronics and consists of integrated circuits (ICs). It is Read Only Memory. It remains even when the computer is switched off.

THEORY

What is flow of information?

Flow of information means the transfer of the information from one place to another through different electronic and optical equipments.

What do you know about Radio Tuning Circuit?

Radio tuning circuit consists of coils of fine wire wounded on a rod which is connected to the antenna. The coils are connected to variable capacitors. The tuned circuit selects signals of only particular frequency.

It does not amplify the signals from transmitters with slightly lower and higher frequencies. The voltage rises and falls as the frequency of the received signal increases or decreases relative to the constant frequency of the oscillator.

Write down the advantages and disadvantages of Fiber Optics.

Advantages of Optical Fibers:

- Waves of visible light has much high frequency than the frequency of radio waves so more information can be sent per second with light beam.
- Fiber optic provides secure and reliable data transmission.
- It is not affected by electromagnetic interference.
- There is no noise and distortion in fiber optics.
- Its error rate is very low.
- It provides high quality transmission and high data transmission rate.

Disadvantages:

- Fiber optics is difficult to install.
- It is quite expensive.

Write a short note on the risks of the Information and Communication Technology to the society and environment.

- Over use of computer is dangerous to health with respect to eyesight and backache.
- Computer crime is accomplished through knowledge or use of computer technology.
- Computers are used to steal money, goods, information and resources.
- Hacking is unauthorized access to computers for any illegal work.

To avoid the above risks we should take care in using the computers. We should use key, ID numbers or finger print password.

What is difference between FTP and HTTP.

FTP:

FTP stands for File Transfer Protocol. It is used as a tool to efficiently uploading and downloading files on the internet.

HTTP:

HTTP is a protocol; web browsing is supported by this function. It allows user to view web page.

THEORY & SOLVED EXERCISE

What is difference between atomic number and atomic mass number?

- The number of protons in a nucleus is called its atomic number. It is denoted by Z.
- The number of nucleons in the nucleus is called Atomic Mass number. It is sum of the masses of protons and neutrons in the nucleus. It is denoted by A.

Give a symbolic representation of a nuclide.

Generally atom is represented by $^{A}X_{Z}$. It is called nuclide where X denotes element, Z is atomic number and A is atomic mass number.

What do you mean by the term radioactivity? Why some elements are radioactive but some are not?

- The emission of radiation by unstable nuclei having atomic number greater than 82 ($Z>82$) is called natural radioactivity. The elements are called radioactive elements.
- The elements with atomic number ($Z<82$) are stable anc do not emit radiation.

How can you make radioactive elements artificially? Describe with a suitable example.

- Artificially produced radioactive elements, by the bombardment of different particles, are called radioactive isotopes.
- Elements having atomic number Z (1 to 82) are stable and non radioactive elements can also be changed into unstable and radioactive elements by bombarding them with protons, neutrons or alpha particles.
- For example, when sodium-11 is bombarded with neutrons, it becomes unstable and excited. Then it de-excites with the emission of gamma rays photon.

What are the three basic radioactive decay processes and how do they differ from each other?

If an unstable parent nuclide X changes into a daughter nuclide Y with the emission of alpha particle, beta particle or gamma particle.

Alpha decay:

After Alpha decay the atomic number of parent decreases by 2 units and mass number A decreases by 4 units.

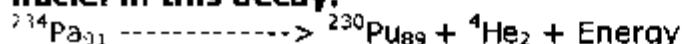
Beta decay:

After Beta decay the atomic number of parent increases by 1 unit and mass number A remains same.

Gamma decay:

The nature of element does not change. It comes back to normal state after excited state. The sign (*) shows that nucleus is in exited state.

Write the alpha decay process for $^{234}P_{91}$. Identify the parent and daughter nuclei in this decay.

$^{234}Pa_{91}$ -------------> $^{230}Pu_{89}$ + $^{4}He_{2}$ + Energy

Explain whether the atomic number can increase during nuclear decay. Support your answer with an example.

- Yes, atomic number (Z) can increase during Beta decay.
- For example Carbon-14 gives Beta decay with Nitrogen-14. After Beta decay its atomic number increases by ' unit and mass number A remains same.

What do you understand by half life of a radioactive element?
The time during which half of the unstable nuclei disintegrate is called the half life of the sample of radioactive element.

Is radioactivity a spontaneous process? Elaborate your answer with a simple experiment.
Yes, radioactivity is spontaneous and natural process. It does not depend upon any change of physical or chemical combination.

Experiment

- A small quantity of the radium source was placed in a hole dug in block of lead.
- The radiations emitted from radium are passed in the space between the two poles of permanent magnet placed inside an evacuated chamber.
- And photographic plate is placed at right angle to the direction of these rays.
- When, after some time, the photographic plate was developed which show three separated spots.
- This proves the existence of three different types of radiations.

What is meant by background radiations? Enlist some sources of background radiations.
Radiations present in atmosphere due to different natural radioactive substances are called background radiations.

Sources:

- In our environment the rocks, soil, water, and air are traces of radioactive elements.
- Our Earth also receives radiat ons called cosmic radiations from outer space. These radiations are high-energy radiations.
- The cosmic radiations interact with atoms in the atmosphere to create a shower of secondary radiations.

Describe two uses of radioisotopes in medicine, industry or research?

1-Tracers:
Tracers are chemical compounds containing some quantity of radioisotope.

Tracers in Medical:
Tracers are used to explore the metabolism of chemical reactions inside the human body, animal or plant. For example, isotcpes of Iodine-131 is accumulated in the thyroid gland and can be used fo· monitoring of thyroid functioning are used for diagnosis of goiter in thyroid gland.

Tracers in Industry:

Tracers are used to locate the wear and tear of the moving parts of the machinery. They can be used to locate the leaks in underground pipes.

Tracers in Agriculture:

The radioactive like Phophorous-32 is used as tracer to find out how well the plants are absorbing the phosphate fertilizer which are crucial to their growth.

2-Medical Treatment (Radiotherapy):

Radioisotopes are used in nuclear medicine for curing various diseases. For example radioactive Cobalt-60 is used for curing cancerous tumor and cells. The radiations kill the cells of malignant tumor in the human body.

3-Carbon Dating (Archeological and Geological uses):

It is the method of age determination of old carbon containing objects (fossils) by measuring the radioactivity of C-14 in them is called radio-carbon dating or simply carbon dating.

What are two common radiation hazards? Briefly describe the precautions that are taken against them.

Radiation Hazards:

- Radiation burns, mainly because if beta and gamma radiations cause redness and sores on skin.
- Radiation can cause Sterility which means inability to produce children.
- Radiation causes genetic mutations in human being and plants. Serious deformations are resulted in newly born children.
- Radiation cause beloved cancer (Leukemia)
- Radiation cause blindness or contracts are formed on eye.

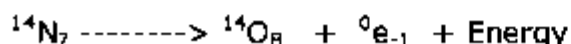
Precautions:

- Sources should be handled with tongs and forceps.
- Rubber gloves should be used and hands should be wasted carefully after experiment.
- Thick lead containers should be used to save radioactive sources.
- A person should never point a radioactive source.
- Radiation sensitive areas should be avoided frequent visits.

Nuclear fusion reaction is more reliable and sustainable source of energy then nuclear fission chain reaction. Justify this statement with plausible arguments.

As the light nuclei are fused to give rise heavy nucleus in nuclear reaction. More energy is released in nuclear fusion as compared to fission reaction. More than 200 Mev energy is released in one nuclear fusion reaction. Its main fuel is hydrogen that is easily available. The main hurdle in sustaining this reaction on earth is the temperature control because very high mum is required to sustain this reaction.

A nitrogen nuclide $^{14}N_7$ decays to become an oxygen nuclide by emitting an electron. Show this process with an equation.

$^{14}N_7$ --------> $^{14}O_8$ + $^{0}e_{-1}$ + Energy

Is it possible for an element to have different types of atoms? Explain.
Yes, an element can have different atoms with same atomic number but different mass number. These are called isotopes of the element.
For example: There are three isotopes of hydrogen called Protium, Deutrium and Tritium.

What nuclear reaction would release more energy, the fission reaction or the fusion reaction? Explain.
The nuclear fusion reaction release more energy as compared to fission nuclear reaction.
Two hundred million electron volt (200 Mev) energy is released in one reaction of fusion.

Which has more penetrating power, all alpha particle or gamma ray photon?
Gamma ray photon has the highest penetrating power, it can pass through 2 cm thick of aluminium and can be blocked by lead.

What is the difference between natural and artificial radioactivity?
Natural radioactivity:
The spontaneous and natural decay of unstable elements (Z>82) into another element with the emission of alpha, beta or gamma radiations is called natural radioactivity.
Artificial radioactivity:
The process in which the stable and unstable nuclide can be changed into radioactive by the bombardment of particles like protons, neutrons etc.

How long would you likely have to wait to watch any sample of radioactive atoms completely decay?
It is difficult to measure the time until whole of the sample cecay. It is supposed to be infinite time.

Tritium $^{3}H_{1}$ is radioactive isotope of hydrogen. It decays by emitting an electron. What is the daughter nucleus?
$^{3}H_{1}$ (Parent – Tritium) ------> $^{3}He_{2}$ (Helium Nuclide) + $^{0}e_{-1}$ + Energy (Beta particle)

What information about the m of the nitrogen atom can be obtained from its nuclide $^{14}N_{7}$? In what way atom $^{14}N_{7}$ is different from the atom in N.
From the symbol $^{14}N_{7}$ it is clear
Z = Atomic number, so number of protons = 7
Mass number A = sum of protons and neutrons = 14
So number of neutrons N = A-Z = 14-7 = 7
Hence it is one of the isotopes of Nitrogen. In Nitrogen atom there are 7 electons.

NUMERICAL PROBLEMS

18.1. The half-life of $^{14}_{7}N$ is 7.3s. A sample of this nuclide of nitrogen is observed for 29.2s. Calculate the fraction of the original radioactive isotope remaining after this time.

Solution: Let half life of $^{14}_{7}N$ is $T_{1/2} = 7.3$ sec.

The original activity $= A_0$

As after time $T_{1/2}$ its activity will become $A_0/2$.

After 2 $T_{1/2} = 2 \times 7.3 = 14.6$ sec. The activity will become $A_0/4$.

After 3 $T_{1/2} = 3 \times 7.3 = 21.9$ sec. The activity will become $A_0/8$.

After 4 $T_{1/2} = 4 \times 7.3 = 28.2$ sec. The activity will become $A_0/16$.

Hence 1/16th of the original sample will be left.

18.2. Cobalt-60 is a radioactive element with half-life of 5.25 years. What fraction of the original sample will be left after 26 years?

Solution: Let half life of *Cobalt-60* is $T_{1/2} = 5.25$ years.

The original activity $= A_0$

As after time $T_{1/2} = 5.25$ years. The activity will become $A_0/2$.

After 2 $T_{1/2} = 2 \times 5.25 = 10.50$ years. The activity will become $A_0/4$.

After 3 $T_{1/2} = 3 \times 5.25 = 15.75$ years. The activity will become $A_0/8$.

After 4 $T_{1/2} = 4 \times 5.25 = 21.0$ years. The activity will become $A_0/16$.

After 5 $T_{1/2} = 5 \times 5.25 = 26.25$ years. The activity will become $A_0/32$.

Hence after 26 years, less than 1/32 of the original sample will be left.

18.3. Carbon-14 has a half life of 5730 years. How long will it take for the quantity of carbon-14 in a sample to drop to one-eighth the initial quantity?

Solution: Let half life of *Cobalt-14* is $T_{1/2} = 5730$ years.

The original activity $= A_0$

As after time $T_{1/2} = 5730$ years. The activity will become $A_0/2$.

After $2\,T_{1/2} = 2\times5730 = 11460$ years. The activity will become $A_0/4$.

After $3\,T_{1/2} = 3\times5730 = 17190$ years. The activity will become $A_0/8$.

Hence 1/8th of the original sample will be left after the 1.72×10^4 years.

18.4. Technetium-99m is a radioactive element and is used to diagnose brain, thyroid, liver and kidney diseases. This element has half life of 36 hours. If there is 200 mg of this technetium present, how much will be left in six hours.

Ans. ***(3.12mg)***

Half life of Technetium = 36 hours

Mass (m) = 200 mg

Time = 6 hrs.

No of half live $= \frac{36}{6} = 6$

Mass of Technetium left after first half life = 100 mg

" " " iind " " " " = 50 mg

" " " iiird " " " " = 25 mg

" " " ivth " " " " = 12.5 mg

" " " vth " " " " = 6.25 mg

" " " vith " " " " = 3.12 mg

18.5. Half-life of a radioactive elements is 10 minutes. If the initial count are is 368 counts per minute, find the time for which count rates reaches 23 counts per minute.

Solution: Let half life of a radioactive element is $T_{1/2} = 10$ mins.

The original activity $= A_0 = 368$ counts per minute.

As after first half life time $T_{1/2} = 10$ min.

The activity will become $A_0/2$ $\frac{368}{2} = 184$ counts per minute.

As after second half life time $2\times T_{1/2} = 2\times10 = 20$ min.

The activity will become $A_0/4 = \frac{368}{4} = 92$ counts per minute.

As after third half life time $3\times T_{1/2} = 3\times10 = 30$ min.

The activity will become $A_0/8 = \frac{368}{8} = 46$ counts per minute

As after fourth half life time $4 \times T_{1/2} = 4 \times 10 = 40$ min.

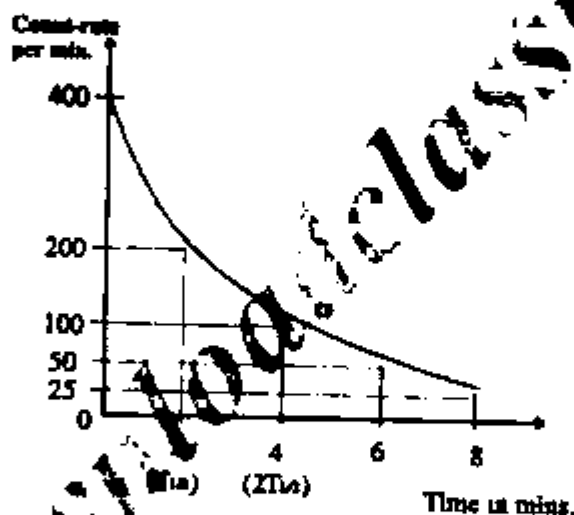
The activity will become $A_0/16 = \frac{368}{16} = 23$ counts per minute.

Hence after 40 minutes its count rate will be 23 counts per minute.

18.6. ***In an experiment to measure the half-life of a radioactive element, the following results were obtained:***

Count rate	*400*	*200*	*100*	*50*	*25*
Time (in minutes)	*0*	*2*	*4*	*6*	[illegible]

Plot a graph between the count rate and time in minutes. [illegible] the value for the half- life of the element from the graph.

Ans.

[illegible] half life $T_{1/2}$ is 2 minutes

18.7. ***A sample [illegible] certain radioactive element has a half-life of 1500 years if it has [illegible] activity of 32000 counts per hour at the present time then plot a graph [illegible] the activity of this sample over the period in which it will be reduced to 1/16 of its present value.***

Solution: **Given Data:**

Let half life of a radioactive element is $T_{1/2} = 1500$ years.

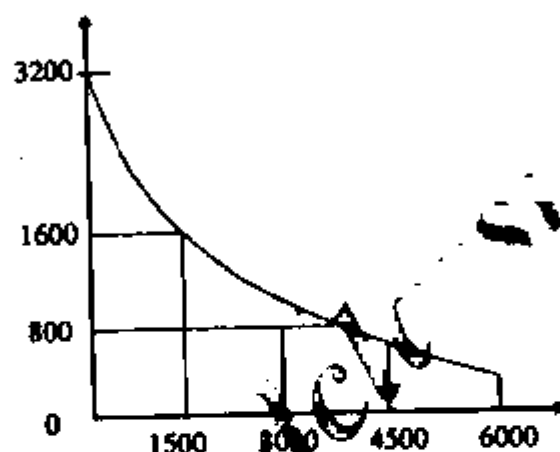
The original activity $= A_0 = 3200$ counts per minute.

First half -life $T_{1/2} = 1500$ years: Activity will be $A_0/2 = \frac{3200}{2} = 1600$ C/m.

Second half life $2 \times T_{1/2} = 2 \times 1500 = 3000$ y: Activity will $A_0/4 = \frac{3200}{4} = 800$ C/m

Third half-life $3 \times T_{1/2} = 3 \times 1500 = 4500$ y: Activity will $A_0/8 = \frac{3200}{8} = 400$ C/m.

Fourth half life $4 \times T_{1/2} = 4 \times 1500 = 6000$ y: Activity will $A_0/16 = \frac{3200}{16} = 200$ C/m.

Count rate	*3200*	*1600*	*800*	*400*	*200*
Time (in years)	*0*	*1500*	*3000*	*4500*	*6000*

18.8. ***Half-life of a radioactive element was found to be 4000 years. The count rates per minute for 8 successive hours were found to be 270, 280, 300, 310, 285, 290, 305, 312. What does the variation in count rates show? Plot a graph between the count rates and time in hours. Why the graph is straight line rather than an exponential?***

Ans. ***(variation in count rate shows the random nature radioactive decay, graph is almost horizontal line rather than exponential curve which is due to long half-life as compared to period of 8 hours)***

Count rate	*270*	*280*	*300*	*310*	*285*	*290*	*305*	*312*
Time succ. 8 hours	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*

Ashes from a campfire deep in a cave show carbon-14 activity of only one-eighth the activity of fresh wood. How long ago was that campfire made?

Solution: Given Data:

We know Half-life of C-14 is $T_{1/2} = 5730$ years

Since the ratio has been reduced by 1/8 (one –eighth).

Therefore three half-lives have passed.

The age of the fossile is given by first half-life $T_{1/2} = 5730$ years

Age of the fossile is given by after 2^{nd} half-life $2 \times T_{1/2} = 2 \times 5730 = 14160$ years

Age of the fossile is given by after 3^{rd} half-life $3 \times T_{1/2} = 3 \times 5730 = 17190$ years